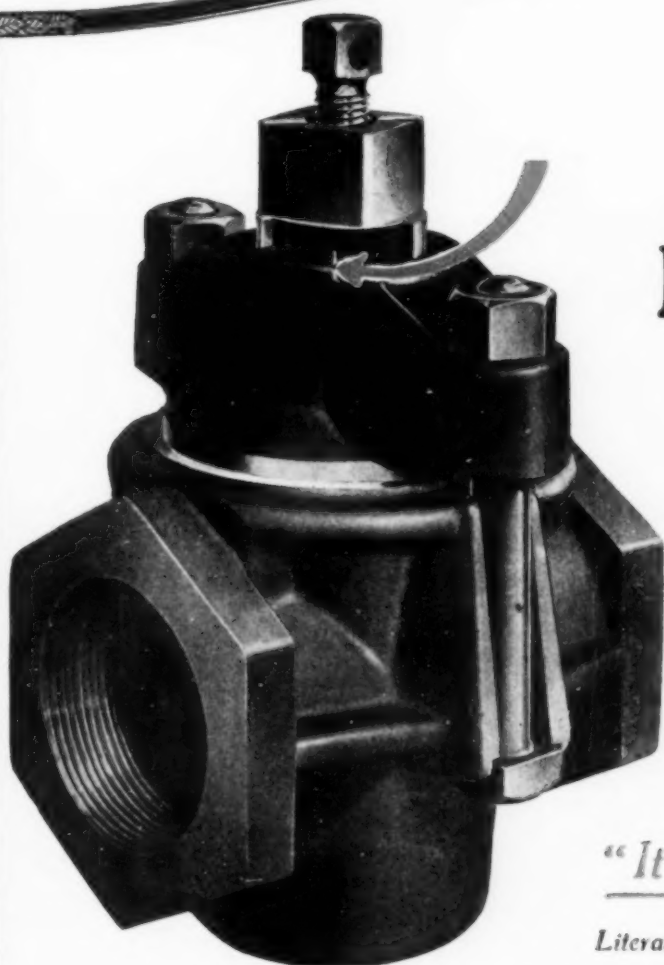


CHEMICAL & METALLURGICAL ENGINEERING

New York, N. Y., July 21, 1920

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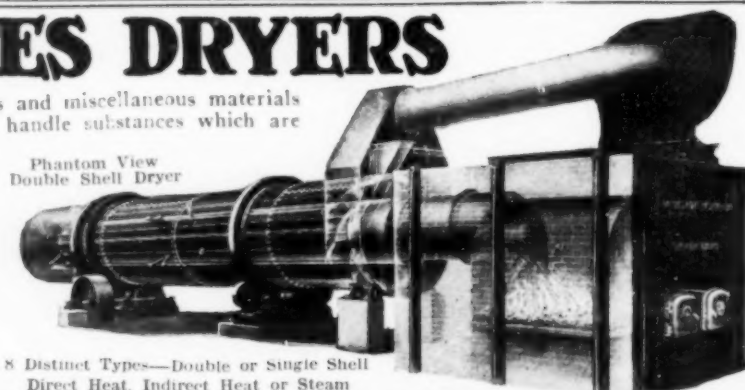
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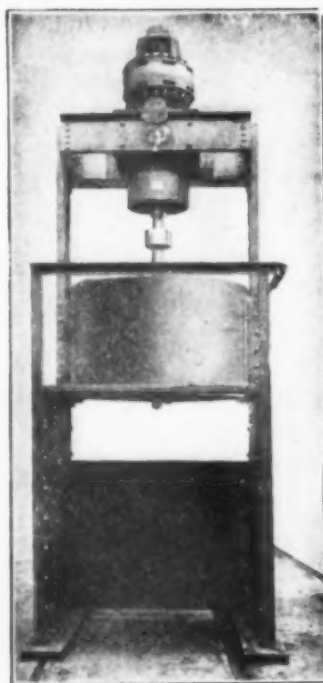
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Would Platinum Registration Be a Safeguard Against Theft?

NUMEROUS large platinum thefts in recent months again emphasize the importance of some drastic measures to forestall further activity of the clever operators who have been so successful recently. One of the most effective proposals to this end which we have heard has been advanced by Dr. W. F. HILLEBRAND, Chief Chemist of the Bureau of Standards, to the effect that some form of platinum registration should be required.

It is recognized by Dr. HILLEBRAND that there are many complications and possible difficulties, and no one has yet suggested exactly how such a plan can be carried through most effectively and safely. It is an important proposal, however, and one which is worthy of very careful attention by everyone interested in the platinum industry whether he is a manufacturer or a user.

An ideal regulation would have national scope and effect, but of course anything affecting commerce in platinum could not legally be adopted by Congress except on the basis of affecting interstate commerce, and much traffic in platinum, of course, is intrastate. It is believed, however, that a registration could be required under internal revenue regulations if a nominal tax upon platinum sales were imposed. Such taxes could be made very nominal, perhaps one-tenth of 1 per cent, and thus amount only to enough to pay the costs of operating the registration agencies. It would thereby put no financial burden upon either manufacturer or user of the metal and the principal objection would be the possible complications and delay in the commercial handling of the material.

However, it is probable that everyone—producer, manufacturer and user—would be benefited despite these restraints, for the recent losses of platinum have been appalling. The Bureau of Standards lost more than \$10,000 worth of metal on one occasion. The University of Missouri and the University of Michigan also suffered losses. The largest loss of all recently reported is a \$40,000 theft from one of the manufacturers in the neighborhood of New York City. Certainly with these hazards accompanying the storage and use of platinum metals, we are justified in encouraging some inconvenience in the traffic. Under the circumstances, it appears that the proposal that all platinum sales should be registered with some appropriate agency is the best solution yet made. In any event, we urge careful consideration of this possibility in the hope that a really effective basis for protection of platinum metals can be developed.

Discussion of the subject by our readers is cordially invited.

A Plan to Co-ordinate University Scientific Research

CONFLICTING testimony on the subject of scientific research in our universities is offered in the annual reports of the president of the Carnegie Foundation for the Advancement of Teaching and the Committee on Chemistry of the Society for the Promotion of Engineering Education. The former is of the opinion that "in the sharp competition for the reputation supposed to come to a university from carrying on research the obligation to teach has become less and less realized, and the teaching of undergraduates, in some of our great institutions, is poor." The Committee, on the other hand, while recognizing frankly the poor quality of much of our instruction, attributes it more to the unceasing grind of class and laboratory work to which instructors are held, and the consequent lack of time for vitalizing research. Perhaps the two views are not strictly comparable, as President PRITCHETT undoubtedly has reference to the larger institutions in which contact between professor and student may be very limited, while the Committee certainly speaks for the smaller institution and the overworked instructor. Both are in agreement on two things: the prevalence of poor instruction and the necessity for research. With the former we will not concern ourselves for the moment, vital though it is; but the latter suggests some constructive comment.

President PRITCHETT says that "the development of a true spirit of research is a necessary part of every true university." And the Committee reports that "more research work must be done at many of the smaller institutions if their teaching staffs are to continue fit to train even undergraduates for the industrial world." With this indorsement, from which few will dissent, we may proceed to examine how best to vitalize research in the educational institutions of the country. The first thing that impresses even the casual observer is that there is no apparent co-ordination of the efforts at research in the different schools; that the subjects for investigation depend on the predilection of the professor, and are likely to be of little or no value; that unimportant subjects for research are often selected in ignorance of gaps in our knowledge that might better be filled; that from a national point of view, at least, there is no definite correlated program, and that much energy and ability are expended aimlessly. This is not framed as a harsh indictment, but merely stated as a condition.

The idea of co-ordinating university scientific research throughout the country is not new, having been the subject of much informal conversation and correspondence. But the time and conditions seem appropriate for the formulation of a definite program toward

that end. The first requisite is a central medium or clearing house, and that is at hand in the National Research Council. This body is cognizant of numerous problems of exact scientific nature or industrial utility that could be apportioned among institutions according to their equipment, physical and mental. The predilection of the investigator might still be catered to, but there would be correlation of his work with that of others and a systematic effort to obtain useful information. The demands of the war showed lack of knowledge along many lines, and the experience of those days can be turned to good account in this way.

The service of such a program to science and industry is but one of the benefits that will result, if we may take the opinion of the Committee on Chemistry previously referred to. It believes in the plan on account of the new vigor it will instil into college and university teachers; for the good example it will set for senior and post-graduate students; and for the influence it will have in retaining good men in the teaching profession. It has already recommended the plan to the National Research Council, and it has received favorable consideration. To us it seems like an excellent opportunity to mobilize a vast amount of energy and ability and train it for great usefulness, and for that reason we are glad to lend our support and encouragement.

Miami Copper Co.

Not in Contempt of Court

THE District Court of the United States for the District of Delaware, HUGH M. MORRIS, Judge, has dismissed the petition of Minerals Separation which sought to have the Miami Copper Co. punished for contempt of court and restrained from further use of its present processes. The order of court is reviewed elsewhere in this issue. It will be observed that, in effect, this order is the same as that of the United States District Court of Montana, dismissing Minerals Separation's petition to find the Butte & Superior Co. in contempt. In that case, it will be recalled, the plaintiff was "remitted to some one of the familiar methods to secure determination upon the merits of these alleged infringements," and was not "permitted to transfer the controversy from merits to contempt." In other words, if Minerals Separation believes that both Butte & Superior and Miami companies are infringing with their present processes, the way is open for new litigation to prove its contentions.

A further order by the District Court at Wilmington making Minerals Separation North American Corporation an additional party plaintiff has an important legal technical bearing in connection with the disclaimer regarding claims 9, 10 and 11 of U. S. Patent 835,120, which are the "small quantity of oil" claims not sustained by the Supreme Court. The question at issue is whether the failure of Minerals Separation North American Corporation to join in the disclaimer might not possibly have the effect of completely destroying the disclaimer and consequently throw out of court all infringement suits so far brought under this patent. Judge MORRIS gives leave to file a supplemental bill making Minerals Separation North American Corporation an additional party plaintiff, but without prejudice to the Miami company to renew its objection to the bill when filed.

Relations Between Institute of Metals, The Foundrymen and Mining Engineers

THOSE men actively interested in the Institute of Metals received something of a shock when they heard that the American Foundrymen's Association had decided to solicit papers on non-ferrous foundry practice, and had appointed a strong committee to attend to this work. They recollected that thirteen or fourteen years ago the American Brass Foundrymen's Association was organized, somewhat as an offshoot from the American Foundrymen's Association, the originators being men who felt that the older body was neglecting the non-ferrous field, especially from the point of view of physical metallurgy. The name was later changed to the American Institute of Metals, and the society bade fair to duplicate the wonderful success of the Institute of Metals, its British junior, certainly with no overwhelming advantage in size of industry or number of personnel to aid it.

In all the years of its existence the American Institute of Metals had made efforts, not without considerable success, to bring out papers and discussion on the so-called "practical" aspects of founding. However, only one who has tried it can realize the difficulty of securing such contributions from men who are qualified by experience in their subject, but not in literary accomplishment. Naturally, then, the *Proceedings* contained more and more pages written by men who were investigating the properties of alloys with microscope, pyrometer and all manner of physical instruments, and who were constantly finding new facts well worth recording, rather than by men who were attempting to establish the best balance between pouring temperature, furnace losses and scrap production, and attaining an approximate solution largely by intangible and indescribable refinements in skillful manipulation. "Scientific" men thus have a double advantage over "practical" men. In the first place, they write more, and practice makes it easier. In the second place, it is far easier to describe a thermal experiment precisely with the help of a cooling curve than it is to describe the proper way to gate a particular casting, even with a dozen sketches.

Meantime the 300 to 400 non-ferrous establishments represented in the American Foundrymen's Association became insistent for papers more nearly applicable to routine problems in the brass, bronze or white-metal foundries, and it was therefore resolved to attempt at least one such session at the annual meeting. Since the fall meeting of the Institute of Metals had been held simultaneously with the Foundrymen, to get the advantage among others of their annual exposition of mechanical appliances, the resolve was communicated to them. Feeling the great difficulty of securing such desirable papers, yet the distinct gain which such discussions should have, no matter from what source, the Institute of Metals decided to work hand in hand with the senior association and to pool their resources so that a real event could result. In this case duplication of effort is apparently needed before even reasonable returns can be expected.

For "American Institute of Metals" the reader should think "American Institute of Mining and Metallurgical Engineers, Institute of Metals Division," in what precedes, since we all know that the two institutions joined forces over a year ago. Whether the fusion was an altogether happy move is a matter on which two opin-

ions may be had; but since it is an accomplished fact all well-wishers of the Institute of Metals and all members of the Mining Engineers who are interested even mildly in the physical metallurgy of alloys should make it a point to see that they are enrolled in the Institute of Metals Division. At present there are many opportunities open whereby such enrollment may be escaped, yet to be specifically a member of the Institute of Metals Division involves no additional financial obligation. It does not exclude the member from participation in any other section or activity whatever of the parent society, but on the other hand it does admit the holder to valuable joint meetings, exhibits and other activities with the Foundrymen's Association as already outlined, will group the member with the leading Americans working with the metallurgy of alloys, and will help perpetuate the identity and influence of a quite honorable and very useful organization.

Steel Industry Functions Well During the First Half of 1920

IN a very trying half year the steel industry of the United States has made an excellent showing. The production was considerably less than the capacity, but the proportion of output to capacity was much higher than in many other industries. It has been made clear that when there are such difficulties as shortage of labor and inefficiency of labor the production of steel is less affected than the consumption of steel, taking the various lines of consumption as a whole.

When it comes to transportation, furthermore, it is seen that a breakdown there does not affect the operation of blast furnaces and steel mills as much as it does business in general. It is true that the steel mills reached the middle of the year with a large quantity of steel unshipped, but the reference here is to the production of iron and steel rather than the delivery. The accumulation of unshipped steel, indeed, reflects credit upon the industry, for the influence of the accumulation would be to restrict production. The manufacturers have shown ingenuity and courage in piling up the steel that they could not ship.

As to actual tonnage, it seems fair to take the steel-ingot producing capacity of the country at 50,000,000 gross tons a year. The half year's production of steel ingots was approximately 21,000,000 tons, or about 84 per cent of previously estimated capacity. And the 50,000,000-ton estimate cannot be considered a low one, seeing that in both 1912 and 1913 the actual production was only a shade over 30,000,000 tons, while the capacity existing at the close of 1913 could not possibly be estimated at over about 35,000,000 tons, so that 50,000,000 tons capacity at the beginning of this year would represent an increase during the war of 43 per cent.

The production of finished rolled steel, in the forms for which the statistics are gathered, normally runs about 76 per cent of the ingot tonnage, on account of scrap and scale losses, the material being eventually recovered very largely, but in the past half year the production probably fell a few hundred thousand tons short of the 16,000,000 tons that this proportion would give. Rather than curtail production of ingots and pig iron further, the mills accumulated ingots and semi-finished steel, thus showing courage and a willingness to perform.

The accumulation of semi-finished and finished steel at mills may be guessed at about 2,500,000 tons, the bulk of this being in finished product, rolled to customers' specifications, this representing between 12 and 15 per cent of the production, the accumulation occurring chiefly during the second quarter of the year.

Even the automobile industry, which has paid fancy wage rates and offered competition with other manufacturers that has been much complained of, can hardly show anything like a ratio of production to capacity of 84 per cent. Some manufacturing industries have been almost completely staid in the past two or three months. As to the railroads, the output in transportation in proportion to physical facilities has been very low, yet it is now admitted by such men as DANIEL WILLARD that the railroads must do much better, in point of efficiency, than their best records of the past. This reference is only to quantity of transportation, in ton-miles. The quality has been particularly low, in point of there being such serious delays and such an ill-assorted movement. The steel industry probably made as good a record in quality as it did in quantity.

Chemical Engineering and The Motion Picture Industry

IN THE development of artistic motion pictures, improvements in projection apparatus and in the art of photography have played an important part, but without the highly developed film which is now available, and lacking photographic chemicals and dyes of excellent quality, it is doubtful whether the "movie" would have become as popular as a form of entertainment. The first requirement, of course, is a film of uniform and excellent quality. The research chemist and the chemical engineer have contributed largely to the results which are now obtainable. There remains, however, an opportunity for the development of materials and apparatus which will make possible the production of better pictures and considerably extend their field of usefulness. The production of non-flammable film is a problem that remains unsolved and the projection of pictures in colors would enhance both their educational and their artistic value.

There is no doubt that should an inexpensive non-flammable film be forthcoming, there would be an increased use of motion pictures, because of their educational value, by schools and by industrial establishments; this would create a demand for an inexpensive, light-weight projection apparatus that could be carried about easily and be operated by electric current obtained from a lamp socket. Even with the film and projection apparatus now available motion pictures have demonstrated their value as aids to the selling of heavy machinery and non-portable mechanical equipment and have been used as an aid to research in metallurgical and other investigations. These are but more obvious possibilities.

For such uses the cost of producing the finished film becomes an item of importance. A description of the production of motion-picture film is given on another page of this issue. It will serve to call attention to a field in which the chemical engineer can render a valuable service to a growing industry.

Fries Made a Brigadier General

IN DESIGNATING Amos Alfred Fries as the head of the Chemical Warfare Service under its new status, provided in the Army Reorganization Act, it is a generally held opinion that the Chief of Staff conferred this distinction upon one who is highly deserving of the honor and entirely capable of discharging the responsibilities of the position. According to the terms of the act, the rank of Brigadier General is bestowed upon the director of the Chemical Warfare Service. Thus, for a second time, Colonel Fries has attained the rank of General. His first commission as Brigadier General was awarded in France Aug. 16, 1918, when he was placed in charge of the chemical warfare section of the American Expeditionary Forces. With the demobilization of the Army, he was returned to his permanent rank of Lieutenant Colonel of Engineers. Since the resignation of General William L. Sibert, he has directed the work of the Chemical Warfare Service with that rank.

When, in August, 1918, he was made chief of the Chemical Warfare Service in France, General Fries was faced by tremendous odds. There was much indifference toward gas, both at home and among the officers of the Expeditionary Force in France. The American Army had little knowledge of gas warfare and gas was regarded as an unimportant factor in the situation. There was not a gas mask in the possession of an American soldier. The searching out and training of officers with a knowledge of chemistry was a most difficult task in itself. Under the stress of those exciting days, the building up of a personnel of the gas service was accompanied by perplexing delays.

Once the nucleus of his staff was formed, General Fries attacked the problems of obtaining supplies, building repair factories and providing for the manufacture of gas shells. Miracles were worked in the old French caserne at Chaumont. It took the most determined efforts to secure anything like the necessary volume of supplies and every increase in personnel was opposed. The accomplishments of those early days, however, attracted wide attention in the Army. The Germans were resorting more and more to the use of gas. The spirit of indifference to General Fries's service disappeared. The Army turned to him, not only for protection from the ravages of the German gas troops but for plans for fighting gas with gas. On the day the armistice was signed, General Fries's command consisted of more than 600 officers and 3,000 men. An expansion was about to be undertaken which would have given the Chemical Warfare Service 1,600 officers and 18,000 men.

Despite the trials and vicissitudes which accompanied the building up of the Chemical Warfare Service, General Fries remarked the other day that nothing in his experience with the American Expeditionary Forces so put him on his mettle as did the carrying out of the command given him personally by General Pershing during the Moro campaign in the Philippines.

General Pershing at that time was a Captain of Cavalry, and during the Philippine campaign he set out on a small expedition against the Moros. His engineer officer was First Lieutenant Amos A. Fries. Contact with the Moros was established in due course, but the wily savages had taken a stand beyond the narrow arm of the lake. General Pershing directed that bamboo rafts be made so that the intervening waterway could be crossed. The building of the rafts came under the jurisdiction of the engineer officer, as did the opening of the passage through a dense cover of water lilies. While cutting this passage, Lieutenant Fries and a raftload of enlisted men became so befouled by the lily growth that they could neither go ahead nor return. The Moros were quick to take advantage of the situation and for more than two hours Lieutenant Fries and his men were under the fire of the tribesmen. Finally they cleared the channel behind them and were able to return to their own forces without casualties. The difficulties of that situation have continued through the years to overshadow any other tight place in which General Fries has found himself. General

Fries can boast of an honor which all Presidential aspirants covet. He was born in a log cabin. It was situated in Vernon County, Wisconsin. His early education was obtained in that neighborhood. His parents later moved to Missouri and finally to Oregon. In 1893 he was graduated from the Medford, Ore., high school. He taught school for a year, trying to devise some plan of entering the Army—an ambition he had cherished since boyhood. The opportunity came in the form of a competitive examination arranged by the Congressman from his district. As the successful candidate, he received an appointment to the United States Military Academy, from which he was graduated April 26, 1898. He was just in time to enter the war with Spain. He served throughout

the war as Second Lieutenant of Engineers. He became a First Lieutenant Feb. 2, 1901; a Captain, June 11, 1904; a Major, Feb. 27, 1912, and Lieutenant Colonel, May 15, 1917.

From Jan. 22, 1911, to June 10, 1914, General Fries was the director of military engineering at the Engineer School at Washington Barracks. He also served for a time as business manager of *Professional Memoirs*, the official publication of the Corps of Engineers, and was, for two years, the editor of that magazine. General Fries was forty-seven years old on March 17.

No more fitting tribute could be paid to him at this stage of his career than to place him at the head of the Chemical Warfare Service, for it was largely due to his energy and zeal that the Army was brought to a realization of the importance of this branch of the service. That he will have the cordial and loyal support of the entire personnel in the service is quite as certain as that he will inspire his subordinates with his own enthusiasm. Both the Army and the chemical industry are to be congratulated on the fact that chemical warfare is in the hands of an officer who is both competent and sympathetic.



BRIGADIER GENERAL A. A. FRIES
Head of the Chemical Warfare Service

Uncovering the Platinum Theft at the Old Hickory Powder Plant, Jacksonville, Tenn.

A Chemical Detective Story in Which Scientific Facts Furnished Clues Enabling the Authorities to Apprehend the Source of the Platinum—Chemical Composition of the Stolen Material a Determining Factor

BETWEEN 4:30 p.m., March 17, and 9 a.m., March 18, 1920, almost 2,200 grams (73 troy ounces) of platinum laboratory ware, mainly crucibles, crucible covers, and dishes, was stolen from the Chemistry Building of the Bureau of Standards. The value of this ware at the time of the theft was nearly \$11,000. The matter was reported to the local police authorities, who immediately commenced an investigation.

During the first week in April information was received through the newspapers and also from the Washington police of the arrest in New York of two men, giving their names as Robert E. Carter and Joseph Fredericks, who were attempting to dispose of about 280 troy ounces of platinum sponge. Lots of 50 oz. and 10 oz. had been left at the offices of two concerns in New York which deal in platinum and the other noble metals. The remainder of the sponge was later found in two rubber hot water bottles in a small grip checked at the hotel where the two men were registered.

CHARGED WITH THEFT FROM CHEMICAL COMPANY

It developed that a certain detective agency had distributed a circular advertising the theft of platinum from the Roessler & Hasslacher Chemical Co., of Perth Amboy, N. J. The metal lost by this company included pure iridium sponge, platinum sponge, platinum sheet, and alloys of platinum and iridium containing 10 and 15 per cent iridium, as well as a considerable amount of gold and silver. This theft occurred between Dec. 26 and Dec. 29, 1919, and a reward of \$5,000 was offered for the return of the metal. The circular mentioned was in the possession of the two concerns to which the platinum sponge had been offered by Carter and Fredericks. The New York Police Department was notified and the men were arrested and subsequently detained, under \$5,000 bail, the charge being that the platinum in their possession was stolen from the Roessler & Hasslacher Co.

Acting on the idea that the platinum in question might include that taken from the Bureau of Standards, the Department of Justice was asked to investigate the matter. At the suggestion of this Department, Dr. E. Wichers, of the platinum laboratory of the Bureau of Standards, was directed to assist in this investigation in New York, working with the office of the United States Attorney and the Bureau of Investigation, U. S. Department of Justice.

SAID PLATINUM WAS MINED IN ONTARIO

In the preliminary hearings, Carter stated that his connection with Fredericks was merely casual and that he had obtained the platinum by placer mining on an unregistered claim in a region about 100 miles north of Parry Sound, Ont. The mining was done by Carter and an associate named H. H. Brooks. The platinum

was brought into the country without declaration to the customs officials. Carter claimed to be a native Canadian and stated that he had been in the United States only on one or two occasions for a very few days. It was noted, however, that he spoke with a marked Southern accent. It was also observed that he wore a silver belt buckle bearing initials "H. H. B." It seemed probable, therefore, that Carter's real name might be Brooks, especially as Carter failed to account for the belt buckle in a satisfactory manner.

Carter gave certain references in Ontario which were investigated by an agent of the Roessler & Hasslacher Co. and found to be false. One of these references gave the name of the Maxwell House as a hotel in Parry Sound. It was also known from statistics of the U. S. Geological Survey that the total annual production of placer platinum in Canada did not exceed 25 oz., and furthermore, that no placer mining of platinum was carried out in Ontario at all. This was subsequently confirmed by the Canadian Department of Mines.

MINING VENTURE STORY FLIMSY

In an interview with the representatives of the Bureau of Investigation and the Bureau of Standards, Carter gave some of the particulars of his mining venture in Ontario and described how "Brooks" had removed the gold from the crude platinum and had then converted the remainder to sponge by dissolving it in aqua regia followed simply by drying and direct ignition of the chloride solution. This was done on the scene of the mining operations with reagents and equipment brought from Trenton and Montreal for this purpose. The story was flimsy enough at best but it was obvious that a chemical analysis of the sponge would clearly distinguish between platinum that had undergone even the simplest refining and the crude mixture of platinum, iron (10-15 per cent), osmiridium and sandy matter which would result from platinum ore treated in the manner described.

It seemed probable, further, that an exact analysis of the seized platinum might help to decide the real origin of the metal in the event that Carter's story should be completely overthrown. Most of the platinum stolen in Perth Amboy was alloyed with 10-15 per cent of iridium. It was estimated that the laboratory ware lost by the Bureau of Standards would contain an average of about 1 per cent iridium, with less amounts of rhodium and probably some palladium and iron. Assuming that very little, if any, refining had been done on the platinum after it was stolen, a simple determination of iridium would have been sufficient to distinguish between these two lots of metal. Accordingly a sample for analysis was obtained from the Police Department.

It was obvious that either the laboratory ware stolen from the Bureau of Standards or the sheet metal taken

from the Roessler & Hasslacher Co. would have to have undergone solution and reprecipitation to arrive at the sponge form of the metal found on Carter. This might involve some change in composition. It was also possible that the seized sponge represented several lots of stolen platinum. It was to be expected, therefore, that the results of the analysis would be of greater value in pointing the way in which the investigation of the theft was to be directed than as testimony in the argument of any particular case.

As already stated, the Roessler & Hasslacher Co. had proved false the Canadian references given by Carter. In fact, the whole of Carter's story was discredited without much difficulty. Since it was impossible, however, to establish any direct connection between Carter or Fredericks and the theft of their platinum, the next step in the argument was that the weight of platinum in Carter's possession was very nearly the weight of the platinum itself which had been stolen from the Roessler & Hasslacher Co., considering that all of the platinum had been carefully refined out of the platinum-iridium alloys. Since no thefts of equal magnitude had been reported, these arguments were presumably sufficient in the minds of the Grand Jury to bring an indictment. Carter and Fredericks were held in the Tombs awaiting trial on this indictment at the time of the developments to be described later.

PLATINUM THEFTS REPORTED IN THE UNITED STATES

Incidentally it may be stated that the weight of platinum taken in nine separate thefts, all from the laboratories of educational and state and Federal scientific institutions, that have been reported to the Bureau of Standards, is about 240 troy ounces. These thefts were all committed since April, 1919, and range from 75 g. to over 2,400 g. in separate cases. Three of the cases represent a total of 205 oz. Adding 342 oz. of platinum and iridium stolen from the Roessler & Hasslacher Co. and about 3 oz. from another industrial concern within the same period, there is a total of about 585 oz., to which the nominal value of \$100 an ounce may be assigned, which had been stolen in about fifteen months and is as yet unrecovered. A few other thefts have since been reported. This is entirely apart from the case to be described in subsequent paragraphs.

To aid in the solution of the general problem of platinum theft, the Department of Justice is anxious to receive information concerning the attempted disposal of large quantities of platinum in any part of the country.

As was pointed out above, no single theft that had been reported was of sufficient magnitude to account for the weight of platinum in Carter's possession. It was, of course, possible that the rightful owners of Carter's platinum had not reported or possibly had not even detected their loss. At any rate, it seemed clear enough that Carter had not come into possession of the platinum in a legitimate manner. For this reason the U. S. Customs Service was preparing to bring action against Carter, in the event of his acquittal, on the ground of his own statement that the platinum had been brought into the country without declaration.

In discussing the entire case, Mr. Schauwecker, of the U. S. Assay Office, who has a very intimate knowledge of the distribution of platinum for war-time uses, made the suggestion that the platinum in question might have been taken from one of the Government munitions

plants. Certain of these plants manufactured sulphuric acid by the contact process and used thousands of ounces of platinum for this purpose. The platinum used in the plants built during the war was refined by the U. S. Assay Office and was converted to chloride solution either by the Assay Office or by the company which operated the plant. The diluted chloride solution was used to impregnate granular magnesium sulphate, giving the needed catalyst for the manufacture of sulphuric acid. Owing to the fact that some of these plants were no longer in operation and were in the process of being salvaged, it seemed not impossible that an undetected theft had been perpetrated.

WAR AND NAVY DEPARTMENTS TAKE INVENTORY

Acting upon this idea, the Bureau of Standards stated the case to the Chiefs of Ordnance in the War and Navy Departments and suggested that an inventory be taken of all the platinum in their possession. The Intelligence Bureaus of both Departments were asked to determine whether anyone known by any of the three names so far applied to the prisoners had ever been employed in any Government munitions plant. Through the efforts of the Washington police, Fredericks had been identified in the National Bureau of Identification as having a police record in Detroit for a minor offense. Carter had no previous criminal record, as far as could be learned.

The investigation by the Intelligence Bureaus yielded no information pertinent to the subject. In the course of a few weeks word was received from the respective Bureaus of Ordnance that the survey of platinum had been completed and revealed no shortage. Owing to the fact that most of the platinum held by the War Department plants was still in the contact mass, it was apparent that the actual amount of platinum on hand could not have been determined and that as a matter of fact this could not be done without a very extensive series of assays or a complete recovery of the platinum in the mass. This was acknowledged to be true by officials of the Ordnance Bureau.

ANALYSIS OF CARTER'S PLATINUM

In the meantime, the analysis of the sample of Carter's platinum had been completed by the platinum laboratory of the Bureau of Standards. The results were as follows:

Total platinum metals	Per Cent 99.29
Loss on ignition in porcelain crucible over blast lamp (volatile matter)	0.67
	99.87

Analysis calculated on "non-volatile" basis, i.e., 100 per cent metals:

	Per Cent
Iridium	0.33
Rhodium	0.10
Iron	0.01
Platinum	99.56
	100.00

Gold, copper and nickel were not detected. Spectroscopic examination revealed the presence of a trace of palladium, as well as small amounts of aluminum, titanium and magnesium. Traces of calcium and strontium, and possibly of silicon, were found. The platinum sponge in Carter's possession was apparently homogeneous except for the presence of small lumps of

a yellowish brown substance which on ignition yielded platinum sponge and gave off chlorine fumes. A microscopic examination of the product of the ignition of these lumps and of the main mass of sponge was made by Dr. E. T. Wherry, of the Bureau of Chemistry. This examination showed the sponge to be of an indefinite structure except for the presence of groups of well-defined octohedra which were judged to be pseudomorphs after crystals of ammonium or potassium chloroplatinate. The potassium line had not appeared in the spectrum of the sample and the conclusion seemed warranted that the platinum had been precipitated as ammonium chloroplatinate from a solution of the chloride, and the precipitate ignited to sponge. It is to be noted, however, that the octohedral crystals made up only a portion of the mass of the sample. The brown lumps seemed to be incompletely ignited ammonium chloroplatinate and revealed the fact that the conversion of the yellow salt to platinum sponge had been carried out with inadequate facilities or in haste.

METAL OF UNUSUAL PURITY

The main thing to be learned from the chemical analysis as given above was that the platinum was of unusual purity. The very low percentage of iron was especially indicative of this. The low iridium content of the sample was very strong evidence that the platinum did not originate from the platinum-iridium alloys taken from the Roessler & Hasslacher Co. It was entirely improbable that the stolen alloys would have been subjected to sufficient refining to attain the purity indicated by the analysis. The same reasoning tended to eliminate the platinum ware lost by the Bureau of Standards or any other chemical laboratory, inasmuch as this ware contained a probable average of 1 per cent of iridium. It became doubtful, therefore, that further work on the case in hand would yield any results bearing directly on the Bureau's loss. Nevertheless, to aid in the proper administration of justice and to protect the legitimate users of platinum throughout the country, it was decided to continue the investigation.

In addition to the facts already stated concerning platinum-iridium alloys and platinum laboratory ware, it was known that nearly all other platinum of commerce usually contained from 0.5 to 1.0 per cent iridium, if not more. It is true that in the last two or three years the rising price of iridium has caused renewed efforts on the part of refiners to remove nearly all the iridium before allowing platinum to go on the market. However, nearly all the crude platinum which came into the country during the war was handled and refined by the U. S. Assay Office. From the analysis of samples of platinum prepared by the Assay Office and from communication with its officials it was known to the Bureau of Standards that a very high standard had been reached in this refining. Platinum 99.9 per cent pure and better was turned out in large quantities for the Nitrate Division of the Ordnance Department. (Most of this was subsequently alloyed with 1 per cent of iridium.) It was learned that the 5,800-odd oz. of platinum sponge prepared for use in sulphuric acid manufacture at the War Department powder plant at Nitro, W. Va., and the nearly 13,800 oz. for the plant at Jacksonville, Tenn., were also of high purity except that some of the platinum for use at Nitro contained about 0.5 per cent palladium. In view of these facts it was difficult to banish the idea that Carter's platinum came from one

or the other of these plants, especially in view of two "clues" which might otherwise have seemed irrelevant.

It will be remembered that Carter had referred to a "Maxwell House" as a hotel in Parry Sound, Ont. Though this reference was false, it was thought probable that he mentioned the name of a hotel which did exist in some other locality, rather than that he invented a purely fictitious name. It was found that a "Maxwell House" was a well-known hotel in Nashville, which is about fifteen miles from the powder plant at Jacksonville. On the occasion of a second visit to New York on May 6 and discussion of the case with the police, it was learned that at the time of Carter's arrest he had in his possession a cake of soap bearing the stamp of the Ruffner Hotel of Charleston, W. Va., a city in the immediate vicinity of the plant at Nitro. The soap also bore the initials "H. H. B." cut into it with a pocket knife. Failing to obtain any information from the police at Charleston, the New York detectives had apparently abandoned this clue.

It seemed, however, that these two things established positive connection of Carter with Charleston and possible connection with Nashville. This information was used by the Department of Justice agents at Charleston and Nashville in a new attempt to connect either or both of the New York prisoners with these plants. Since the three names ascribed to the subjects did not appear on the employment rolls, and since there was no apparent shortage of platinum, no ground was gained in this way.

COMPANIES HAD EMPLOYEES' PHOTOGRAPHS

It was reported by the Ordnance Department that the Hercules company and the du Pont company, which had operated the plants at Nitro and Jacksonville respectively, had on file at their headquarters offices at Wilmington complete employment records, together with photographs of all employees. Since the agents of the Bureau of Investigation and the Bureau of Standards had seen both Carter and Fredericks, it was thought that an examination of the photographs of the employees would determine whether these men had been employed at either plant under different names than those they now gave. In this connection it should be stated that under the New York law it is impossible to take photographs of persons in custody until after their conviction. Fredericks' photograph had been obtained from his former police record and had been sent to Nitro and Jacksonville without being identified. No photograph of Carter was available to send to the plants and it thus became necessary to make this personal visit in the expectation of identifying him in the employment records of the two companies.

On visiting Wilmington, it was learned that most of the employment records and all of the photographs of employees had been returned to the local offices at the plants after the War Department had assumed active control. Believing that the evidence warranted the assumption that Carter had actually been in Charleston shortly before his arrest, it was decided to proceed to Nitro and examine the records there. Carter could not be identified and unfortunately the photographic files were not complete. Still confident of the logic of the deductions made from the chemical analysis of the platinum in question, the representative of the Bureau of Standards undertook to follow out what seemed to be the last possible lead and proceeded to Jacksonville.

The visit to the Jacksonville plant met with sudden success. Aided by what was really a fortunate accident, Carter was identified as H. H. Brown, who had been employed as a salvage foreman until his departure from the plant on March 27, on ten days leave. On April 20 he had been discharged for unexplained absence. While it seemed that Brown had had no possible means of access to the platinum stocks of the plant, the manner in which he had obtained the 280 oz. found in his possession was to be explained by the next important development, which followed within an hour after Brown's identification. This was the receipt by the Nashville office of the Bureau of Investigation of the following letters, which were written by a man in the Tombs prison in New York and addressed to his wife. The letters were intercepted and sent to Nashville from the office of the District Attorney of New York City, where it was believed that the letters had to do with the traffic in narcotics. The letters were published in the Nashville papers on May 30:

LETTERS FROM SUSPECT TO HIS WIFE IMPLICATE CRONE

May 14, 1920—Dear Wife: Just a few lines, hoping it finds you in the best of health as it leaves me, and I hope you have sent me that letter, and I have sent a letter to the lawyer to come down and see me, and I want you to call him up so to make sure that he will come down, and you should not worry about what I have said to Uddie. I did not mean to say that you are keeping the money for yourself. I know any time you have a dollar I could get it, so please don't take it up the way you mean. I will send Jack Noyer a letter and explain to him that you are sticking to me and that they could trust you with any amount of money, and I am going to try to lay my bit off for two weeks and then I will see what I should do, and Monday I want you to get ready to go out of town and when you are there you should tell this party that Robert Carter is under \$5,000 bail, and they will raise the bail to about \$15,000, and he should give you at least \$20,000 worth of stuff, and he should put them in 25 ounces in each package, and you could get about \$85 or \$90 an ounce. The reason why you are asking for that amount is because Carter will not be able to leave town as soon as he gets out on bail so he will hafta stay in New York a few days so that no one is folling him around, and he need some expense money, and he will jump bail and never come back to New York, and as soon as you get this stuff from the fellow you should get a vault and put the stuff in there. You could get a vault at the Bowery and Grand Street, and you could get for the stuff \$100 a ounce, and each package should bring you \$2,500, and the address is where the fellow is working at the Old Hickory Powder Plant, his name is H. R. Crone. Telephone of the place is Hadley 4601, when you get that number tell them to connect you extension 93 and if that ain't the wright number look up the telephone book for Old Hickory Powder Plant and this powder plant is about 20 miles away from the city and you should get yourself a round trip ticket to Nashville, Tennessee, and when you get there you should ask for a good hotel and you should ring him up on the phone and tell him you are the party from new York and you have a letter from Carter for him and he will come around to you in an auto and call for you. You are to ask him where he could meet you and tell him that everything is O.K., and that Carter is not saying a word and he trusted your husband as being that I can not get out so you made the trip for me, and tell him as soon as Carter gets out Carter will explain him what kind of a fellow I am to him and as I have no more to say I will close and send you my best regards and also with love. I remain yours husband, Joe. P.S. you do as I tell you you will be worth a big piece of money in a short time.

Old Hickory Powder Plant, H. B. Crone, Tel. Hadley 4601, Ex. 93; office hours from 8 to 4.

May 15, 1920—Dear Wife: Just a few lines hoping it finds you in the best of health as it leaves me and I have sent a letter out to Meyer for one of the boys I put in just as you have stated to me and I have sent a letter to my mother stating she would give you one

hundred dollars, but she will not get that letter until Monday and the fellow from the lawyer's office was down to see me and he could not get in so I send him the answer down what I wanted and before you get out of the house always look for mail and I hope you have received the two letters Saturday, one for yourself and the other one for the party out of town. And everything will be arranged for you when you get that party and may be you will hafta stay at the hotel a day or two. And you should make yourself that you are very wise and tell him that you have a buyer that will take all the stuff that he has at the price from 85 to 90 dollars a ounce. JOE.

CRONE IS ARRESTED

Crone was kept under surveillance for several days until the agent of the New York office of the Bureau of Investigation obtained from Brown the confession that the platinum in his possession was obtained from Crone, who had stolen it from the reserve stock of platinum at the plant. Crone's arrest followed immediately upon Brown's confession. Up to the time of the present writing, Crone has denied any guilt in his handling of the platinum at the plant.

HOW THE THEFT WAS CONSUMMATED

About the first of March, Crone, as chief chemist of the plant, was directed to convert the reserve stock of platinum chloride solution, representing almost 2,300 oz. of platinum, to platinum sponge, place it in sealed aluminum cans, and transfer it to the custody of the accounting office, where it was placed in a safe inside of the vault in this office. About 75 oz. of platinum was handled at a time and the work was completed between the middle and the last of April. The safe contained eighty-eight of these sealed containers, each bearing a label indicating the weight of platinum (about 25 oz.) it contained. After Crone's arrest, the contents of these cans were examined. Of the eighty-eight cans, two contained platinum. One of these was the first one placed in the vault. The other represented a quantity of chloride solution which would only half fill one of the cans. The remaining eighty-six cans contained what appeared to be a mixture of mercury with ordinary moist dirt, the ratio between the two being carefully adjusted so as to fill the can completely and also give the correct gross weight to the sealed can.

REMAINDER OF PLATINUM TAKEN NOT YET FOUND

It is presumed that Crone's defense will be along the line that Brown is shielding the real thief, who gained access to the vault and made the substitution there. One of the most interesting details of Brown's confession was that Crone had directed him to sell some of the platinum in order to provide funds for Crone's defense "when the crash came." Brown disclaims any knowledge of the whereabouts of the platinum except that which was in his possession, which is the total amount that has been recovered to date. Crone and Brown had both worked in the Parry Sound, Ont., region. There was no evidence to indicate that Fredericks was implicated in the theft of the platinum or in the attempted disposal of it except that he acted as a guide for Brown in New York.

Examination of the register of the Ruffner Hotel at Charleston disclosed the fact that Brown registered there on March 28, the day after he left Nashville. It was learned that his stop at Charleston, while on the way to New York, was in the nature of a visit and apparently had no connection with the stolen platinum or the Government plant at Nitro.

Developing, Printing and Assembling of Motion-Picture Film

BY L. W. CHAPMAN

AN IDEA of the size of the motion-picture film industry may be gathered from the statement that more than 270,000,000 lin.ft. of film valued at more than \$10,000,000 was exported from this country during 1919 and that an estimate of the total amount manufactured in the United States is given as in excess of two billion feet, valued at approximately \$75,000,000. As the process is carried out in the motion-picture laboratories, the cost of developing, printing and assembling approximately equals that of the cost of the film.

The description which follows is of the process as conducted in the two laboratories of the Famous Players-Lasky Corporation at Los Angeles, Cal., at which nearly a million feet of film is used per week.

Film as received from the manufacturer is without perforation and this, then, is the first operation per-



FIG. 1. DARK ROOM

formed in the laboratory. These perforations are made by automatic machines and the film, if to be used for negative, is wound in 400-ft. (122-m.) lengths on camera reels; if used for positive the film is wound in 400-ft. rolls and when printed is cut into 200-ft. lengths. Negative film has a silver bromide base, and that from which the prints, or positives, are made has a silver chloride base.

In the laboratory dark room the exposed negative is looped on cedar frames holding 200 ft. (61 m.) of film and on which the film remains throughout the operations of developing, fixing, and washing. Wooden developing tanks are used which hold 180 gal. (680 l.) of developer and accommodate five frames at one time. These slide in vertical grooves at the ends of the tank. The developing of the negative requires from twelve to fifteen minutes in a solution made up according to the following formula: Metol $1\frac{1}{2}$ oz., potassium bromide $2\frac{1}{2}$ oz., hydroquinone $5\frac{1}{2}$ oz., pyro 2 oz., sodium sulphite 9 lb., sodium carbonate $4\frac{1}{2}$ lb., water 80 gal. (42.4, 70.8, 148.8, 56.7, 4,082, 2,041 g. respectively to 303 l.). The bath is maintained at a temperature of from 18.3 to 18.8 deg. C., copper coils being provided through which warm or cold water can be circulated as required. In



FIG. 2. WASH ROOM

Fig. 1 is shown the operation of looping the film on frames, the inspection of a partly developed film and the washing of the developed film before fixing. The development is conducted so as to produce what is termed a "soft negative," the printing of the positive being relied upon to bring out contrasts. Development of the negative is in the hands of experienced operators and their judgment is relied upon to determine the degree to which it is carried.

After development is complete the film is removed from the tank, washed by immersing in a tank containing running water and transferred to a tank similar to the developing tank, containing the fixing solution which is made up as follows: hypo 800 lb., chrome alum 30 lb., sodium sulphite 32 lb., sulphuric acid 85 oz., water 300 gal. (363, 13.6, 14.5 and 2.4 kg. to 1,135 l.). Film remains in the fixing bath for fifteen minutes. From the fixing bath the frame is transferred from the dark room through a light-proof vestibule to the lighted washroom. The washing is conducted in two stages by immersing the frame in tanks containing running water, the flow of water being such that a complete change is made in five minutes, the operation requiring one-half hour. The washroom is shown in Fig. 2.

In drying the film much care is needed. The operation is carried out by revolving the film on reels. (Fig. 3.)



FIG. 3. DRY ROOM

These reels are made by spacing cedar slats about 8 in. (20 cm.) apart on wheels 4 ft. (1.22 m.) in diameter. The reels are 10 ft. (3 m.) in length and will carry about 1,200 ft. (36.6 m.) of film. The reels are revolved by means of an electric motor at 50 r.p.m. and the drying operation requires about three-quarters of an hour. In order to prevent the film from curling the rate of drying must not be too rapid and the moisture in the atmosphere of the dark room, the wash-room and the drying room is therefore maintained at about 60 per cent relative humidity by an automatic air-conditioning apparatus which washes, humidifies and circulates air through these rooms, and also maintains the room at a uniform temperature. Dust particles are a source of trouble, being a cause of "light specks," and in order to produce a film free from this defect it is essential that the air in the rooms be washed.

For the production of a five-reel story requiring 4,500 to 4,800 ft. (1,370 to 1,460 m.) of film, from 20,000 to 30,000 ft. (7,000 to 9,000 m.) of negative may be taken. After the negative is developed and dried a sample or "rush" print is made which the director, or "film editor,"



FIG. 4. NEGATIVE CUTTING AND ASSEMBLING ROOM

"cuts to the action." Titles and any directions for the dyeing, printing or toning of the positive are returned with the edited print to the laboratory. The titles are photographed from wash drawings and in the laboratory are treated the same as other negatives. The negative is cut to correspond with the "edited" positive and assembled together with the titles by scenes. (Fig. 4.) These are then cemented together in proper sequence in lengths of about 200 ft. and after inspecting, cleaning and dusting are ready for printing.

As a five-reel story may contain three hundred or more scenes many of which have been taken under varying light conditions there results variation in the density of the negative. It is important that uniform intensity of illumination be obtained when the film is projected on the screen. This result is accomplished by controlling the printing operation.

Since each scene is photographed under uniform conditions as affecting the lighting of the subject, the length of film representing one scene will produce when developed a negative of uniform density. Each scene is "light tested" to determine the amount of exposure to be given in the printing operation to produce a print of a standard density. The light test is carried out by

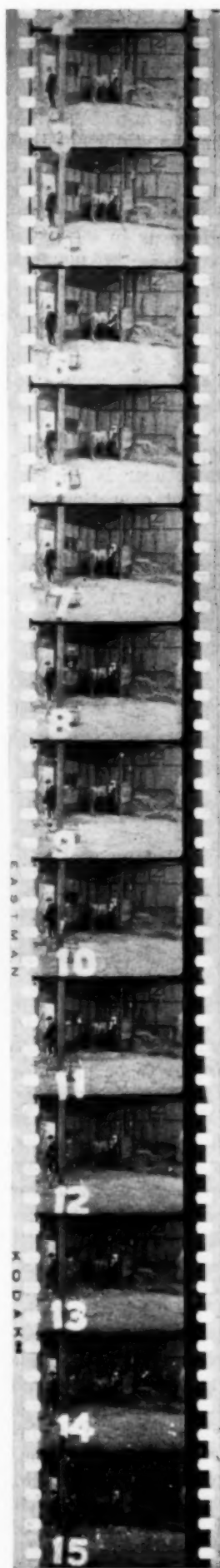


FIG. 5. PORTION OF A "LIGHT TEST" PRINT

printing a length of the negative from the first portion of a scene corresponding to that of twenty-two pictures or about 16½-in. film. This print is exposed by means of the "light test" box. This box is light-tight except for a ground glass top which is the width of the film and 16½ in. (26.7 cm.) in length. There is painted near the edge of the ground glass in small figures the numbers from 1 to 22; these are spaced ¾ in. (1.9 cm.) centers so that a number will be printed in each individual picture. A standard 40-watt frosted-globe tungsten lamp is placed at one end of the test box and about 4 in. below the ground glass. The illumination of the ground glass and therefore the amount of exposure of a positive made through the ground glass is then more intense at the end near the source of light, and a print will be obtained showing gradual increase in density from the picture numbered 22, which is nearest the lamp, to that numbered 1, which is furthest away. The time of exposure is automatically and absolutely controlled and is therefore the same for all tests. The test prints are developed for exactly three minutes in the standard developing bath, which is maintained at the standard temperature. These prints are fixed, washed and dried in the usual manner. A portion of a "light test" print is shown in Fig. 5. A "light test" card is made out for each reel of 200 ft. of negative and on this card are noted the scene number, a brief title of the scene and any directions for toning or dyeing of the print. The light test prints are inspected over a ground glass which is uniformly illuminated and the inspector selects the picture which has the desired density. The number which is printed in this picture is recorded on the light test card. (Fig. 6.) In making the light test a notch is cut in the edge of the film to locate the beginning of each scene and title.

The printing is performed in a Bell & Howell electrically operated printing machine. (Fig. 7.) The negative and the film to be printed are passed



FIG. 6. LIGHT TESTING

at a uniform speed by an aperture, the area of which may be varied and through which the film is exposed to the light from a standard 40-watt frosted globe tungsten lamp, the negative being pressed firmly against the positive by air pressure. The exposure aperture is of the same width as the film, but the opening in the other direction is controlled by the machine operator, the amount of opening being controlled by a lever, a pointer on the end of which swings over an arc on which are printed the numbers from 1 to 22. The printing operation is begun by setting the pointer to correspond with the number which was recorded on the light test card for the first scene. The light is turned on and the motor which winds the film through the printing machine is started. The negative before reaching the aperture passes through a device by which the notches which have been cut in the edge of the film at the beginning of each scene are made to sound an audible click. This click indicates that another scene is about to pass

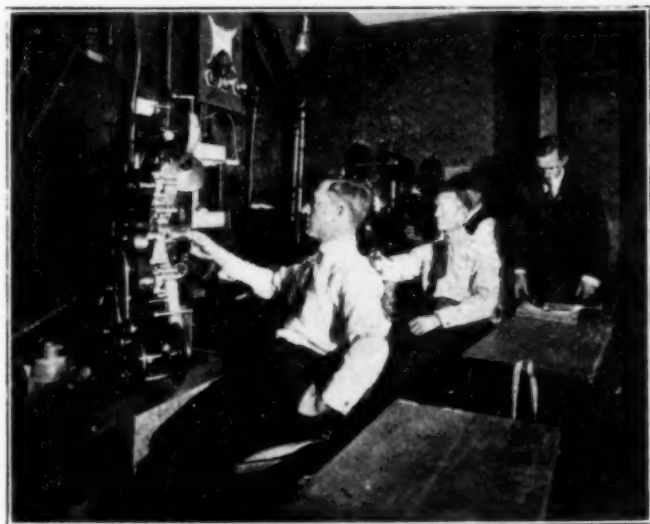


FIG. 7. PRINTING ROOM

the aperture and the operator moves the pointer to the number on the arc which corresponds to the number given on the light test card for the succeeding scene. The printing is in this manner controlled so that a positive of uniform density is obtained. The machines print at a rate of 62 ft. (18.8 m.) of film per minute.

Direct current at constant voltage is used in the light test and printing.

The exposed print or positive is wound on frames and goes through the same treatment as the negative, using, however, a developer having the following composition: Metol 6½ oz., hydroquinone 64 oz., sulphite 14 lb., carbonate 20 lb., bromide 4 oz., made up to 80 gal. with water (184, 1,813, 6,350, 9,070, 113 g. respectively to 303 l.). After fixing and washing the film may be dyed or toned and these portions are printed and developed separately. The films are dyed by immersing in tanks similar to the developing tanks containing a water solution of the dyes. Several dyes may be used in sequence on the same film and it is possible to obtain from forty-five to fifty different tints from nine dyes in this manner. In addition to uniform coloring of the print, different tints for the high lights, half-tones and full tones may be obtained, depending on the relative adsorption of the dyes which result from variations in the thickness of the deposit.

After washing, the print is dried in the same man-



FIG. 8. INSPECTING ROOM

ner as the negative. The prints are assembled into lengths or "reels" of about 1,000 ft. (305 m.), dusted in vacuum dusters, projected to inspect for defects (Fig. 8), measured and packed in galvanized iron tins which are packed in wooden boxes for shipment.

It will be noted that a considerable amount of waste film results from the various operations. This is purchased by a company which collects the waste film from several of the studios. The silver deposit is dissolved from the film by means of "lye" or caustic soda, and the silver recovered. The same company also collects the solutions containing silver from the motion-picture laboratories and the silver from these is also recovered. Considerable quantities of the waste film are used by manufacturers of celluloid products.

We are indebted to Frank V. Biggy of the Morosco Studio of the Famous Players-Lasky Corporation, Los Angeles, Cal., for the illustrations, and for courtesies extended in the collection of these notes.

Engineers and Scientists in Westminster Abbey

MR. E. J. MEHREN, editor of the *Engineering News-Record*, who is traveling in Europe, has contributed to his journal the following interesting observations on a visit to Westminster Abbey:

Until yesterday I did not know that there was in Westminster Abbey a well-defined location for the tombs and monuments of scientists and engineers. We all know of Poets' Corner and of the Royal Chapels which contain the bones of many of England's kings and queens, but the engineers' and scientists' corner (an inadequate description for one spot in the quiet nave and in the north aisle) has not been celebrated in the descriptions of the Abbey that have come to my hand. Consequently I was the happier at the discovery.

Against the screen of the choir stalls, looking into the nave, is the monument of Sir Isaac Newton, while directly in front, well out in the center of the nave, are the tombs, under the pavement, of Telford and George Stephenson, Telford's marked by one of the small square pavement stones cut with his name and Stephenson's by a full length floor panel—a work of art in bronze. A statue of Telford stands elsewhere in the Abbey. What a fitting home for the long sleep of these master engineers! Above them springs the wonderful Gothic nave, airy in its lightness, yet built of stone—a sight such as I have never seen. The master builders of a later age lie asleep beneath the work of the master builders of all time, masters who outrivalled those of ancient Egypt or Greece or Rome—the Gothic cathedral builders of the thirteenth century. Egypt built great temples and mighty pyramids; so did Greece and Rome. But structurally the forms were simple. With the high-flung naves and crossings and choirs of the Middle Ages came engineering problems of no mean order. Yet so well were the principles understood that wonderful grace and appearance of lightness were secured. Today, with all our advances, we do nothing to equal their master works.

But to return to the engineers in Westminster: By the side of Newton, directly in front of the Newton monument, lies the body of the late Lord Kelvin, while 20 ft. to the north, in the aisle, lie, side by side, the bodies of Herschel, the astronomer, and of Charles Darwin. Above these vaults, casting on them a light mellowed by the art of the stained-glass worker, are a memorial window to Sir Benjamin Baker, the inscription recording two of his great works—the Forth Bridge and the Assuan Dam—and another to Lord Kelvin, "Engineer and Natural Philosopher," as the inscription has it. In this same north aisle are memorial windows, also, to Stephenson, Joseph Locke, designer of the Crewe engine; Brunel, Trevithick, and Charles William Siemens.

The Siemens window looks down on a group of tablets to scientists—to Lister, the physician; Darwin; Hooker, the botanist; Adams, the astronomer, and Joule, the physicist. The Joule tablet bears this inscription: "This tablet is here placed near the graves of Newton, Herschel and Darwin by those who in many lands have united to perpetuate the memory of James Prescott Joule, F.R.S., of Manchester, in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat."

In the central part of the nave and the north aisle are buried other great men with kinship to engineers. We find the tomb of Sir Charles Lyall, the geologist. It is covered by a brass-lettered slab bearing this tribute: "Throughout a long life he sought the means of deciphering the fragmentary records of the earth's history, in the patient investigation of the present order of nature, enlarging the present boundaries of knowledge and leaving on scientific thought an enduring influence." Out in the center of the nave, near the graves of Telford and Stephenson, are four graves placed with singular appropriateness under this great nave—mortal remains of four architects who played an important part in the revival of Gothic architecture. They are Sir Charles Barry, architect of the Houses of Parliament; Sir George Gilbert Scott, George Edmund Street and John Loughborough Pearson.

As I turned to leave this part of the Abbey, after musing there an hour, I chanced to walk over the Telford inscription and my eye caught on the slab at Telford's feet the name of Livingstone—David Livingstone, the African explorer—and the thought struck me that he was in kindred company. He explored an unknown country; he extended the bounds of knowledge regarding a section of the earth's surface. So did Telford and Stephenson and Lyall explore the unknown; so did they, and their great fellow engineers and scientists about them, extend the bounds of knowledge. They, no less than he, were explorers of a dark continent and have placed humanity under tribute for all time.

London, May 9, 1920.

Expansion of French Chemical and Oil Industries

The chemical industry of France continues to attract large amounts of capital and it is evident that it will become one of the leading industries of the country. Among recent company incorporations is found that of the Société Alsacienne de Produits Chimiques, with 16,000,000 francs (1 franc = \$0.193 normal exchange), capital to take over the former German-owned Kesther establishments at Thann-Mulhouse (Alsace) in addition to a large modern plant at La Rochelle, formerly making war chemicals, which will now be used for the manufacture of synthetic camphor, sulphates of copper and potash, and a trade-marked brand of butterine.

The distribution of petroleum, fuel, and lubricating oils is also receiving the attention of capitalists. Two companies recently floated by local bankers of La Rochelle for operation in this consular district are the Société pour l'Importation des Huiles Combustibles, capital 5,000,000 francs, and the Société de Fabrication de la Vaseline, capital 1,400,000 francs. Other late incorporation of companies to deal in chemicals and oils and their capitalization are: Société Française Ratocczyn (gasoline, heavy oils, carburents, etc.), 23,000,000 francs; Société Pax (essential oils and other chemical products), 1,000,000 francs; Société pour l'Approvisionnement des Consommateurs d'Huiles Combustibles, 2,500,000 francs; Société la Pétroléenne, 22,000,000 francs; Société Chimique et Industrielle des Monazites (chemicals and the manufacture of thorium, cerium, mesothorium, and other rare metals), 2,500,000 francs; Société des Hydrocarbures et Produits Industriels, 10,000,000 francs; Société de la Silice (pulverized silicates and an artificial product) 600,000 francs.

The soap and similar industries are expanding and many new companies are being formed.

Some Investigations in Briquetting Oklahoma Coal*

By J. C. DAVIS

TESTS were recently conducted at Oklahoma University to determine whether the briquetting of certain Oklahoma coals, using a crude oil residue as a binder, could be profitably carried on commercially. While the process in itself is not new, some interesting data were obtained.

BUREAU OF MINES RESEARCH

The Bureau of Mines has made extensive researches on the subject of briquetting and briquetting materials in its plants at Norfolk, Va., Pittsburgh, Pa., and St. Louis, Mo. Binders of various kinds were tried, including both inorganic and organic materials. Among the inorganic materials tried were clay, lime, magnesia, magnesia cement, plaster of paris, portland cement, natural cement, slag cement and water glass. Some of the organic materials experimented with were wood products, such as rosin, pitch and pine tar; sugar-factory residues such as beet pulp, beet sugar molasses, and cane sugar molasses; starches, tars and pitches from coal, such as blast-furnace tar, producer-gas tar, coal-tar creosote and various grades of pitches from various tars; natural asphaltum and petroleum products such as crude oil and crude oil residue. Anyone interested in these results may find a complete summary of the experiments in Bulletin No. 58 of the Bureau of Mines.

TESTS AT OKLAHOMA UNIVERSITY

The experiments made in the Materials Testing Laboratory, at the University of Oklahoma, were conducted by C. T. Griswold, mining engineer for the Atchison, Topeka & Santa Fe R.R., assisted by the writer, and it is with his permission that the data given herein are made public. After consulting the bulletin above referred to, it was assumed that a standard mixture should be made of 90 per cent moisture and a 7 per cent binder. The coal was then ground and thoroughly washed to rid it of slate and other impurities so far as practicable.

In order to carry out the tests a hollow cast-iron mold was made approximately $4\frac{1}{2} \times 4\frac{1}{2} \times 2\frac{1}{2}$ in., with a central hole of about $1\frac{1}{2} \times 2\frac{1}{2}$ in., with rounded corners. A base plate was made so as to have a projecting rim extending into this opening from the under side. A plunger, sufficiently long to compress the coal, passed down through the opening from the upper side. The mold was then filled with the coal and binder; the plunger was placed in position and the mold put under the compression head of the 100,000-lb. Riehle testing machine resting on the self-adjusting lower head. Trouble was experienced in getting the briquets to come free from the mold, due to the roughness of the casting, and it was decided to have the entire inside of the mold finished, together with the projecting portion of the base plate and the plunger. The briquets then came out freely, perfect in shape, and of a size to give a weight of approximately 2½ oz.

A number of experiments were then made to determine the best pressure to use. Pressures were tried out varying from 1,000 to 5,000 lb. per sq.in. The former pressure seemed too low to compress the binder properly into the coal. At a pressure of about 2,000 lb. per sq.in.

the materials seemed to unite very satisfactorily. An increase to 3,000 lb. per sq.in. did not seem to improve the binding qualities materially and with pressures above this amount the particles of coal were crushed. It was therefore assumed that 2,000 lb. per sq.in. would be the proper pressure to use in the briquetting work.

TYPE OF OIL EMPLOYED

The binder used was a Wheeler crude oil. Tests were first made to see what reduction from the original volume would be necessary in order to give a satisfactory binder. Oil was reduced to 50 per cent of its original volume and continued by 10 per cent reductive steps down through 40, 30, 20 and 10 per cent. A 15 per cent grade was then made and found highly satisfactory. Briquets were formed using 5, 6, 7 and 8 per cent of each binder. In all cases the briquets were soft and could easily be crushed in the hand after having had time to cool completely and to harden until the 20 per cent reduction was reached. The 10 per cent seemed too hard and rather brittle, while briquets made from the 15 per cent were excellent.

The distillation test furnished by the oil company showed this crude oil to contain an asphalt base of 36 per cent—10 deg. penetration. The laboratory check made at the university showed the following:

STEAM DISTILLATION FIGURED ON BASIS OF DEHYDRATED CRUDE

	Per Cent
Kerosene distillate (40.5 deg. B ₆)	2
Gas oil (34.3 deg. B ₆)	14
100 viscosity (at 100 deg. F.) lubricating oil	21
Fuel oil (calculated)	43
Residue	15

A binder was then made at the Cameron Refining Co., at Ardmore, Okla., to meet these specifications and was found to check with the above distillation test. Further tests on this binder registered penetration 26 at 25 deg. C. by New York penetrometer, 50-g. weights being used for five seconds. The melting point as shown by the ball and ring method is 126 deg. F. These tests lead to the following final specifications:

An asphalt binder with a penetration of 20 and a melting point of 160 deg. F. to withstand the excessive summer heat of this section. It is safe to assume that any other asphalt answering these specifications would be equally satisfactory for use. It may be necessary in any case to require a slightly higher melting point.

THE COAL USED

The coal used in all these tests was ground to pass a 10-mesh after studying the action of $\frac{1}{4}$ -in. to 60-mesh. The 10-mesh did not seem to crush under the pressures needed for the purposes of satisfactory briquetting. The samples used were made from all coals passing a $\frac{1}{4}$ -in. round hole screen and contained both the slack and the finest dust mixed in the proper proportions of 31 to 9. Analyses of these coals showed the following percentages:

	Lehigh Unwashed	Lehigh Washed	Average Slack of McAlester-Wilburton
Moisture	2.30	2.79	2.04
Ash	19.54	12.10	10.93
Volatile matter	31.20	31.23	35.83
Fixed carbon	48.04	53.32	53.23
B.t.u.	10,710	12,200	

B.t.u. tests on the finished briquets showed the unwashed samples to contain 10,543 B.t.u. and the washed ones 12,570 B.t.u. Washing appears to increase the B.t.u. about 20 per cent.

Temperature and moisture variations were tried throughout the tests, temperatures being tried between

*Abstract from paper presented before the chemists and engineers meeting at Tulsa, Okla.

60 and 450 deg. F.; and moisture variations of from 3 to 10 per cent. It was found that the best results were obtained when the temperature was kept between 180 and 200 deg. F. When moisture contents between 3 and 5 per cent were used, there did not seem to be much difference in the quality of the briquets, but when 5 per cent was exceeded they showed voids and crushed much more readily.

Some of the briquets were subjected to rolling and drop tests. Twenty lb. of the briquets made from unwashed coal was placed in an oil barrel and the barrel rolled over the rough ground for two minutes at 32 r.p.m. These briquets showed a loss in weight of $3\frac{1}{2}$ per cent. Some of them were then dropped from a height of 6 ft. three times onto a concrete floor and showed a loss of 1 per cent from this test. The washed briquets, then subjected to the same treatment, showed losses of $1\frac{1}{2}$ per cent from rolling and $\frac{1}{2}$ per cent from dropping. None of the briquets of either kind were broken into parts, the losses being due to breaking of the edges and corners. The height of the drop was then increased to 12 ft. and they were then broken into parts only on the third drop, showing in all cases clean cut cleavage planes. Any of the briquets tested were sufficiently strong to withstand the pressure of a man's weight as shown by placing them on the floor and stepping on them.

BURNING TEST

As the "test of the pudding is in the eating," so the test of the fuel is in the burning. A fire was made in an ordinary round heating stove having $\frac{3}{4}$ -in. grate openings. The fire bed was 8 in. deep. Both kinds of briquets kindled readily, burned freely, made no more smoke than an ordinary coal, and did not soften, disintegrate or fall through the grate bars during the process of combustion. The washed coal briquets, however, made a much hotter fire. The unwashed left a refuse of 28.7 per cent and clinkered badly, leaving a hard consolidated clinker. The washed coal briquets left a refuse of 11.6 per cent and showed only a small amount of soft clinker.

CONCLUSIONS

These tests show beyond doubt that the Oklahoma soft coal of the above grades can be successfully briquetted, will make a cleaner domestic fuel than the ordinary bituminous coals, and will stand handling and rough usage to a remarkable degree. As a locomotive fuel they would no doubt prove very satisfactory. The initial cost for a plant to make briquets of a desirable kind is high, but it is believed that these briquets can be made to sell at a price no higher than the better grades of bituminous coal and will give greater satisfaction to the consumer.

Losses of Crude Oil by Evaporation

A recent report of the Bureau of Mines makes the statement that "The evaporation of crude oil without doubt causes one of the largest single losses to which the oil is subjected after it is taken from the ground. The few days during which crude oil is stored on the lease before being taken by the pipe line causes an aggregate loss per year from evaporation estimated at 122,100,000 gal. of gasoline in the Mid-Continent field alone. This has a value, at 22c. per gal., of \$26,880,000 and represents about 3 per cent of the total gasoline produced in the United States from all fields and all sources."

Position of Nitrate-Producing Companies in Chile

The large Chilean companies are adding to their present holdings by buying out the smaller concerns and acquiring further nitrate deposits not yet worked. It is reported that some of the British companies desire to sell out because of burdensome taxation on their capital in England, but this cannot be verified. It is quite probable that if these companies would sell out it would be to some Chilean company and the property would be worked as before. The feeling in the nitrate industry in Chile at the present time is most optimistic, based on the probable demands from central Europe, principally Germany, which has always been a large user of nitrate as fertilizer, and the fact that the production of the artificial, or, rather, electrically manufactured nitrate, has not been so successful as anticipated and cannot compete with the natural product of the deposits in Chile either in price or quality.

PRICES OF NITRATE INCREASE

There have been several reasons why the nitrate-producing companies did not show large profits last year, the principal one being the small demand after the armistice was signed, amounting to an almost complete suspension during the early part of the year 1919, and only about 55 per cent of the "oficinas" (works) were in operation during the second half of the year. The second cause of the small profits for the year 1919 was the fact that contracts had been made at a low price, 9s. per quintal, for their output for deliveries up to the end of March, 1920. (The Spanish quintal, which is in use in the nitrate industry of Chile, is equivalent to 101.4 lb.)

When the price began to go up toward the end of the year the producers did not share in the increase nor in the higher prices prevailing during the past three months of this year, the prices going as high as 16s. 1d. per quintal in April, and at the present time 16s. 3d. is asked by the brokers. The cost of production in the meantime had risen considerably, owing to strikes of the workmen and the stevedores in the ports of shipment, making the cost delivered alongside much higher than in September, 1919. This, of course, made a reduction in the profits of the companies producing the nitrate of soda.

COMPANIES IN GOOD CONDITION

However, at the present time the old contracts at the low price have practically all been completed and the new contracts will be made at prices over 15s. per quintal, possibly over 16s. per quintal, and the companies will therefore be in a better position than at any time since the armistice was signed to do a profitable business, and it is therefore not likely that they would care to sell out their plants at a time when the future for a prosperous business seems almost assured. Some of the smaller plants might sell out or merge with one of the larger companies.

The German nitrate companies are uncertain and it is reported that some are in financial difficulties and might have to be sold out.

Press telegrams dated from London report that the German nitrate company called "Augusta Victoria" has made some inquiries as to the possibility of the sale of its Chilean properties to an American syndicate. This is one of the largest German companies and has its office in Bremen.

The Acid Bessemer Process*

BY RICHARD S. McCAFFERY†

THIS paper considers certain aspects of the acid bessemer process, particularly in its relations to the duplex process—that combination in which the pig iron is first desiliconized and decarburized in acid bessemer converters and then dephosphorized in basic open-hearth furnaces. The acid bessemer process employs an acid-lined converter and produces an acid slag. The blow is usually thought to eliminate the silicon and manganese as oxides and then to burn off the carbon as carbon monoxide. On account, however, of the relatively large amount of metallic iron present in the converter, compared with the relatively small amount of the impurities it is desired to oxidize, the first reaction in the converter probably is the formation of iron oxide, which dissolves in the bath and acts as an oxygen carrier for the silicon and carbon. As soon as iron oxide is dissolved throughout the bath, the oxidation of silicon commences; but in the early stages of the blow the mass law would indicate that iron oxide must form first, and this oxide probably increases up to some saturation point. The molten metal in the converter from the early stages of the blow right through to its completion remains basic, while the slag produced is siliceous. This fact is shown by the corrosion of the acid bottom and the tuyères, which is greatest at the tuyère orifice where oxidation is most active and where there is the most iron oxide.

ADVANTAGE OF BASIC TUYÈRE BLOCKS

Why does this acid bottom corrode? Because it is attacked by a base. The thought, therefore, suggests itself, why not make the bottoms of basic or neutral material? As the converter slag is acid, those parts of the converter coming in contact with the slag should be acid; but those parts of the converter that are in contact with the molten metal saturated with metallic oxides should be basic or neutral. Bessemer operators have for some time tacitly admitted this condition, for the blast pressures have steadily increased with the object of keeping the metal in suspension, and so preventing bottom corrosion; if the molten metal were not basic, it would not attack an acid bottom. In addition, the tuyères are bunched together at the middle of the bottom and a clear space is left around the outside of the bottom; if tuyères are placed too near the side walls, the wall corrosion increases. If the increase of blast pressure in bessemer converters was for the sole purpose of hastening the blow by getting more oxygen into the converter in the same time, the number of tuyères might have been increased, thus increasing the volume of air and decreasing the blast pressure. It is not desirable, though, to follow this procedure, because the additional tuyères can be provided only by placing them near the side walls, which results in increased lining costs.

In a normal blow, the carbon stage begins after the oxidation of the silicon, the carbon burning largely to carbon monoxide; it thus does not generate sufficient

heat to raise the temperature of the bath during the latter part of the blow; the great rise in bath temperature takes place in the early stage when the silicon is burning. Many converters, though, particularly those of larger capacity, do not blow a charge in this way; they show a temperature rise during the latter part of the blow, the carbon being burned to dioxide instead of to monoxide, with the resulting liberation of 97,000 calories instead of 29,000 calories. As a matter of fact, many blows that are not initially of too high silicon content are finished at excessively high temperatures, in some cases running up to 1,800 deg. C. Although the bad effect of this practice is known and attempts are made to lower the final temperature by the addition of scrap to the converter or by the introduction of steam in the air blast, the best method of lowering this temperature, by burning the carbon to monoxide, which also decreases by one-half the power consumption during the carbon stage of the blow, is not used because it is necessary to keep the metal charge away from the converter bottom.

ECONOMY IN LOWER BLAST PRESSURES

By following the present practice the direct bottom expense may be reduced seemingly, by employing a high blast pressure, but the power cost is greatly increased and the temperature of the finished blown metal is very high; or if the finishing temperature is kept down to the proper point, there is the extra expense of scrapping or of steaming. It does not seem right to charge scrap in a process that has as one of its principal objects the production of scrap, or to expend energy for excess air in order to turn carbon to dioxide when the extra amount of air will be furnished by the atmosphere at the converter mouth. By this plan a vicious cycle is in operation: more energy is employed for blowing in more air, which produces more heat, which requires more energy, in the form of steam, to lower the temperature. With the use of basic or neutral bottoms, blast pressure may be reduced and the tuyère area increased because the basic charge will not corrode bottoms of this character. The actual blowing time then can be materially shortened, no scrapping or steaming is necessary, and a colder blown metal is produced.

The author has already pointed out² the possibilities of decreasing the time of blow and decreasing the power consumption with the use of a greater number of tuyères and lower blast pressure; and Table I summarizes the data obtained in a test of a 23-tuyère bottom compared with a bottom designed by the writer containing 35 tuyères.

TABLE I. RESULTS OBTAINED BY INCREASING NUMBER OF TUYÈRES AND DECREASING BLAST PRESSURE

	Old-style Bottom	New-style Bottom
Number of tuyère blocks, each containing twelve 1-in. tuyères.....	23	35
Weight mixer metal, lb.....	47,000	50,000
Blast pressure at engine, lb. per sq.in....	28	22
Total engine revolutions per blow.....	589	443
Time of blow, minutes.....	14	10½
Comparison of time, per cent.....	100	69
Comparison of power, per cent.....	100	60

IMPORTANCE OF TEMPERATURE IN DUPLIXING

In the open-hearth stage of the duplex process, the temperature of the open-hearth bath is an important factor if the dephosphorizing operation is to be successfully carried out, also the temperature of the blow metal passing from the converters to the open hearth

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*Paper to be presented at the Lake Superior meeting of The A.I.M.E., August, 1920.

†Professor of Metallurgy, University of Wisconsin.

²The use of basic and neutral material for making the bottoms in acid-process steel converters is protected by U. S. Patent No. 1,338,655, issued April 27, 1920.

²Iron Age, (1919), vol. 103, p. 626.

is of great importance. To obtain maximum capacity in the open hearth, just as soon as it is ready for the blow metal, the blow metal from the converter should be ready to be poured in; and when the kicker charge is introduced, the bath should be at the proper temperature for the reactions to take place in the proper order. It should not be necessary to raise or lower the temperature of the heat very much. If the temperature of the molten bath in the open hearth is too high, the carbon is burned off first and after nearly all of it has been eliminated the phosphorus is oxidized and slagged. If the bath temperature is correct, the phosphorus reaction takes place first and the heat is finally worked down to the desired carbon content. Carbon is much more active in taking oxygen out of the molten metal than is phosphorus, with the result that when the process is carried out at the proper temperature and the heat is finished on carbon, the steel produced is much less likely to contain oxygen than when the heat is finished on phosphorus. The importance of this point, with respect to the bessemer stage, is that under certain conditions, already pointed out, the converters may furnish blow metal at an excessively high temperature which may be poured into an open hearth that, for various reasons, may be at a higher temperature than normal, with the result that the order of reactions in the open hearth is reversed and the open-hearth product may contain oxygen.

When running down at the end on phosphorus in this way, there is a twofold danger. If oxygen additions are made for the purpose of getting out the phosphorus, there is a chance that the steel will carry oxygen, although it may be thoroughly dephosphorized; whereas if there is not sufficient oxygen-carrying material charged to eliminate the phosphorus, the metal may not contain oxygen, but it will not be dephosphorized. The alternatives then, when an open-hearth bath is finished on phosphorus, are that the metal either will be oxidized or the phosphorus will not be eliminated, whereas, if the order of reaction were changed and the phosphorus were removed first and the carbon taken out at the end, the carbon would protect the metal from oxidation after dephosphorization and good steel would be produced.

It is not claimed that this happens in every open-hearth heat, but it does happen in some. This sequence of happenings can be avoided and the possibility of oxygen-carrying steel being made will be cut down to a minimum if excessive blast pressures are avoided. This can only be done economically, in the opinion of the writer, if basic or neutral converter bottoms are employed. The use of these bottoms will avoid the high blast pressures and cut down the power cost by burning the carbon to monoxide. In accomplishing both of these, the production of overheated blown metal will be minimized and the possibility of producing oxidized steel will be very slight.

Asbestos Can Be Fine Spun

The earliest use of asbestos was for spinning and weaving, to make incombustible thread and yarn rope and cloth, and this has continued to be the most important use of asbestos ever since the days of the Greeks and Romans. Only the best grades can be used for this purpose, according to J. S. Diller, of the United States Geological Survey, Department of the Interior. Thread can now be spun so fine that it will run about 32,000 feet to the pound.

Use of Domestic Graphite in Crucibles

The Bureau of Mines reports in Bulletin 112, "Mining and Preparing Domestic Graphite for Crucible Use," that prior to 1915 practically all of the graphite and clay used in the manufacture of crucibles in the United States was imported. The graphite came chiefly from Ceylon, Madagascar, and Korea, while the clay was obtained principally from Klingenburg, Bavaria. Domestic graphite was for the most part used in the manufacture of paint, lubricants, foundry facings, etc.

As a result of cessation of imports of clay, due to the war, manufacturers in this country sought a native product to replace it, and a substitute was soon found which compared very favorably with the foreign article.

The use of domestic flake graphite, however, in proportion to more than 25 per cent mixed with imported graphite was not very successful.

However, the domestic graphite mining and milling industry expanded rapidly under pressure of war conditions, being aided by a request of the War Trade Board on August 10, 1918, that crucibles manufactured during the balance of 1918 should contain 20 per cent domestic flake and 25 per cent thereafter. At the end of the war there were 39 graphite plants in Alabama, 3 in New York, 5 in Pennsylvania and 3 in Texas.

The graphite investigation of the Bureau of Mines covered three phases: (1) Field examination of the graphite deposits in the states mentioned, and a study of the methods used in mining and preparing graphite for market. (2) Experimental work on the concentrating and refining of crucible graphite to improve the quality of the product and lessen waste. (3) Experimental work in crucible manufacture to determine the property of domestic flake and the maximum proportion that might be used without impairing the quality of the crucible.

The present importance of these investigations lies in the fact that the domestic industry, if it is to survive the competition of imported graphite, which can be mined and prepared more cheaply than domestic graphite, must rely on improved and more efficient methods of producing and preparing graphite. Also for full extension of the market to domestic producers, crucibles made entirely of domestic or nearly all domestic flake in combination with domestic clays should be developed.

Peat Production in Norway

Smolen Island, near Kristiansund, N., is a flat spot of land possessed of immense areas of peat bog. It is doubtful whether there is anywhere a better location for the production of peat in large quantities.

Some time ago a company was organized under the name of "Smolen Co." It owns large areas on the island, and has a modern plant with six large machines for preparing the peat for market, after which it is transported on tracks down to the company's wharves.

It is expected that 30,000 tons will be produced this year, increasing till production reaches 50,000 tons a year.

Even a coasting steamship company serving the local trade in that vicinity has used peat for its steamers, enabling them to keep up their routes to full extent, while other local lines had to reduce their sailings because of the coal situation.

The "Smolen Co." intends also in the near future to extend its business to the manufacture of coal briquets for use by steamers and factories.

Properties and Constitution of Glues and Gelatines—III

Relations Between Physical Properties and Chemical Constitution and Influence of Size of Molecule Upon Physical Constants—Proximate Constitution and Jell Strength—Study of Magnesium Sulphate Precipitation of Larger Protein Particles*

By ROBERT H. BOGUE, PH. D.

ATTEMPTS are constantly being made to correlate the physical characteristics of substances with their composition, their constitution and their molecular structure, and, by developing specific relations between these, to thereby account for and explain the particular behavior of the substances in question.

Since but little effort has been made by other investigators¹ toward the establishment of a relationship between the viscosity and jell strength of glues and gelatines and their constitution, it seemed desirable that a study be made with this end in view. This investigation was accordingly initiated, and a clear-cut relationship has been established.

PROXIMATE ANALYSIS

Several sets of experiments have been performed to show whether or not any relation exists between the proximate constitution of glues, and their jell strength and viscosities. These experiments covered glues of every grade and variety. They were analyzed for water, ash, organic matter and nitrogen.

A study of the results obtained from these determinations, shows that:

The water content of the air dry glues varies directly as the jell strength.

The total organic matter varies inversely as the jell strength.

There seems to be no consistent variation with jell strength in the case of ash or nitrogen.

The consistent variation with respect to water signifies only that the water-retaining capacity of glues runs parallel to the jell strength, and that whatever factor controls the one controls likewise the other.

Examples of the data obtained are given in Tables XXVI and XXVII.

TABLE XXVI. RELATION BETWEEN PROXIMATE CONSTITUTION AND JELL STRENGTH

Grade	Jell Strength	Per Cent Nitrogen	Per Cent Water	Per Cent Ash	Per Cent Organic Matter
H 1	79	14.70	.....	.....	.....
H 2	78	14.74	.....	.....	.....
H 3	75	14.18	13.66	3.89	83.45
H 4	74	14.49	.....	.....	.....
H 5	73	14.56	.....	.....	.....
H 6	71	14.43	.....	.....	.....
H 9	60	13.88	12.15	3.70	84.15
B 1	75	14.61	.....	.....	.....
B 2	69	14.18	13.33	2.95	83.72
B 3	65	14.35	.....	.....	.....
B 4	58	14.54	.....	.....	.....
B 5	55	14.56	.....	.....	.....
B 6	52	14.16	.....	.....	.....
B 7	50	14.59	13.06	3.15	83.78
B 8	48	14.61	11.85	3.41	84.70
B 9	liquid	14.40	10.68	3.35	87.48
Pressure B 9	liquid	14.24	.....	.....	.....

*For Parts I and II, see CHEM. & MET. ENG., vol. 23, Nos. 1 and 2, July 7 and 14, 1920, pp. 5 and 61.

¹Trotman and Hackford [J. Soc. Chem. Ind., vol. 23 (1904), p. 1072] developed a relationship between the "gelatinose" precipitated in a saturated zinc sulphate solution and the "consistency" of the jelly, which is in agreement with one of the relations hereinafter described.

TABLE XXVII. RELATION BETWEEN PROXIMATE CONSTITUTION AND VISCOSITY

Viscosity	Jell	Water	Ash	Organic Matter	Nitrogen
47	H ₄	14.30	2.80	82.90	14.75
48	H ₄	13.30	3.90	82.80	14.36
49	H ₄	13.10	4.14	82.76	14.44
50	H ₄	13.85	4.03	82.12	14.51
51	H ₄	12.00	3.04	84.96	14.69
52	H ₄	12.30	2.20	85.50	15.00
54	H ₄	13.30	3.56	83.14	14.66
46	H ₂	14.46	3.74	81.80	14.65
47	B ₂	13.80	2.91	83.29	14.49
48	B ₂	13.36	2.97	83.67	14.61
49	B ₂	12.90	3.03	84.07	14.66
50	B ₂	12.14	2.10	85.76	14.83

NITROGENOUS ANALYSIS—PRELIMINARY TESTS

Study of Magnesium Sulphate Precipitation. In the study of proteins which have been to a greater or a lesser extent hydrolyzed, it has been customary to distinguish in these products of hydrolysis four distinct groups of substances. These are known as proteins, proteoses, peptones and amino acids. There are many sub-groups which have been designated positions in the series but they are not separated in this study.

The proteins² are designated as those groups which are precipitated by half saturated solutions of ammonium, zinc or magnesium sulphate. The proteoses are those groups which are precipitated between half and complete saturation. Peptones and amino acids are not precipitated at saturation of the above salts. The amino acids may be determined in this filtrate by the nitrous acid method of Van Slyke,³ or by the formol-titration method of Sørensen,⁴ and the peptones calculated.

Ammonium sulphate was not used in the precipitations, as it would involve a troublesome correction in the nitrogen determinations. Magnesium sulphate was used as being the less expensive of the remaining salts. The formol-titration method of Sørensen was used for the amino acid determinations.

To determine the most favorable conditions for precipitation and to study the errors in the process, two glues were treated by various methods as follows:

TABLE XXVIII. STUDY OF NITROGENOUS SEPARATIONS

	No. 8	No. 9
(a) Total nitrogen (by Kjeldahl, 1 g.)	0.1427	0.1420
(b) Protein + proteose nitrogen (saturation by MgSO ₄)	0.1316	0.1274
(c) Peptone + amino acids (filtrate from b)	0.0100	0.0150
(d) Protein nitrogen (half separation by MgSO ₄)	0.1013	0.0906
(e) Proteose nitrogen (by complete saturation by MgSO ₄ after removal of protein)	0.0222	0.0299
(f) Proteose nitrogen (b - d)	0.0303	0.0368
(g) Peptone nitrogen [a - (b + i)]	0.0091	0.0113
(h) Peptone nitrogen (c - i)	0.0080	0.0117
(i) Amino nitrogen (Sørensen method)	0.0020	0.0033
Accounted for	0.1416	0.1424
Loss	+ 0.0011	- 0.0004

²Schryver, "Allen's Commercial Organic Analysis," vol. 8, pp. 467-495.

³Van Slyke, J. Biol. Chem., vol. 12 (1912), p. 275; and vol. 16 (1913-14), p. 121.

⁴Sørensen, Biochem. Z., vol. 7 (1907), p. 45, et seq. See also Schryver, loc. cit., p. 488.

A study of the relations expressed above led to the adoption of the following scheme in analysis.

Each sample weighed out and made up to such volume that 50 c.c. contains one gram.

A 50 c.c. aliquot used for total nitrogen.

A 50 c.c. aliquot saturated with magnesium sulphate for the estimation of protein plus proteose nitrogen.

A 50 c.c. aliquot treated with 50 c.c. saturated magnesium sulphate solution for estimation of protein nitrogen.

Proteose nitrogen estimated by difference between protein plus proteose nitrogen and protein nitrogen.

Amino nitrogen determined by Sørensen's method¹⁰ in filtrate from precipitation by saturated magnesium sulphate.

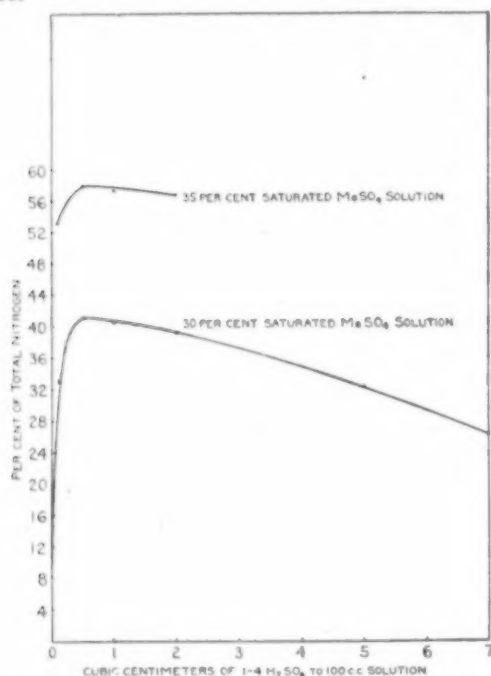


FIG. 14. EFFECT OF SULPHURIC ACID ON PROTEIN PRECIPITATION

Peptone estimated by difference between total nitrogen and the other three groups.

Effect of Temperature. That considerable variation in the uniformity of the magnesium sulphate precipitation might be due to variations in temperature was evident. This point was tested out carefully by precipitating a series of glues and allowing them to stand at different temperatures.

The data show that the solubility of the proteins varies directly as the temperatures, there being from 3 to 8 per cent more protein nitrogen thrown down at 17 deg. than at 25 deg. C.

TABLE XXIX. EFFECT OF TEMPERATURE ON PROTEIN PRECIPITATION

No.	Grade H4, 30 per cent saturated $MgSO_4$ precipitations		
	Precipitated at 25 Deg. Filtered at 25 Deg.	Precipitated at 17 Deg. Filtered at 17 Deg.	Precipitated at 17 Deg. Filtered at 30 Deg.
1	41.9	50.1	41.3
2	44.8	52.0	46.0
3	50.9	57.7	49.7
4		58.3	50.3
5	55.5	58.7	51.7
6	56.2	59.4	52.2
7	53.7	56.2	50.9

From the above, it is evident that wherever comparisons are desired between the nitrogenous substances

¹⁰Loc. cit.

precipitated from different glues, it becomes necessary to work under carefully controlled temperature conditions, or else run a complete set simultaneously. Otherwise wide variations may be expected. A temperature of 25 deg. C. was used in the following determinations as being the most convenient.

Effect of Varying Amounts of Sulphuric Acid. It was found that some acid must be added to the nitrogenous solution or to the magnesium sulphate in order that precipitation should result on the mixing of the two solutions. S. B. Schryver¹¹ has recommended the addition of 2 c.c. of dilute (1-4) sulphuric acid to each 100 c.c. of above mixed solutions. This point was tested by the addition to a glue of varying amounts of dilute sulphuric acid, from $\frac{1}{16}$ to 10 c.c. of a 1-4 solution, precipitation being brought about by a 30 and 35 per cent saturated magnesium sulphate solution.

It will be seen that in both instances the maximum precipitation was produced by the addition of $\frac{1}{16}$ c.c. of 1-4 solution to 100 c.c. of the precipitating mixture. Both above and below this amount the nitrogen thrown down decreases. This amount was therefore used in all determinations.

The data are given in Table XXX, and are expressed graphically in Fig. 14.

TABLE XXX. EFFECT OF SULPHURIC ACID ON PROTEIN PRECIPITATION

Glue H4, 1 g. glue. Total volume solution, 100 c.c.		
C.c. 1-4 H_2SO_4 Added	30 per Cent $MgSO_4$ per Cent of Total N	35 per Cent $MgSO_4$ per Cent of Total N
0.0	2.95	...
0.1	33.2	53.3
0.5	41.3	57.9
1.0	40.3	57.3
2.0	39.3	57.0
5.0	32.4	...
10.0	17.5	...

Study of the Formaldehyde Titration. The usual directions for the formaldehyde titration¹² specify that the formaldehyde and the solution containing the amino acids should both be made faintly pink to phenolphthalein before mixing. It was found, however, that if these instructions were followed in our case, the solution resulting from the mixing would become intensely red, making a determination impossible. The control of saturated magnesium sulphate responded similarly. The process was therefore modified as follows: the amino acid solutions in saturated magnesium sulphate, and the control, were made faintly pink to phenolphthalein. The formaldehyde was treated with sodium hydroxide until, on adding 25 c.c. of it to 100 c.c. of the control, the intensity of the original pink remained unchanged. A drop more of the base would cause an intensifying of the color; a drop less a decrease or removal of color. The amino acid solutions were then treated similarly and titrated back to a uniform, rather deep, red with barium hydroxide in N/5 concentration.

The relative accuracy of the formaldehyde titration method with different concentrations of amino acids was studied as follows: Two g. each of two glues were hydrolyzed with hydrochloric acid for 24 hr. These were filtered, clarified with a silver chloride precipitation, refiltered, made up to 200 c.c. and aliquots of 50, 25, 10, 5 and 1 c.c. removed in duplicate and titrated for amino acid content.

At the higher concentrations the color of the solution

¹²Loc. cit., p. 484.

¹¹Loc. cit., p. 488.

interfered with the accuracy of the end point, and at very low concentrations the errors of manipulation became large in comparison with the weight of sample. The intermediate concentrations check very well. It was therefore decided best that the entire filtrate from the

TABLE XXXI. EFFECT OF CONCENTRATION ON FORMALDEHYDE TITRATION

Volume, c.c.	Weight, g.	No. 8		No. 9	
		Ba(OH) ₂ c.c.	Per Cent N	Ba(OH) ₂ c.c.	Per Cent, N
50	0.50	14.0	8.12	15.0	8.70
50	0.50	13.7	7.94	13.1	7.60
25	0.25	7.7	8.92	7.5	8.68
25	0.25	7.9	9.16	7.3	8.48
10	0.10	3.1	9.0	3.0	8.7
10	0.10	2.8	8.1	2.9	8.4
5	0.05	1.4	8.2	1.5	8.8
5	0.05	1.4	8.2	1.4	8.2
1	0.01	0.30	8.7	0.25	7.3
1	0.01	0.25	7.3	0.27	7.8

precipitation by saturated magnesium sulphate be used in all amino acid determinations. The data are given in Table XXXI.

RELATIONS OF NITROGENOUS CONSTITUTION TO JELL STRENGTH

Having found no fundamental relation to exist between the proximate constituents of glues and their jell strength, it was decided to separate their nitrogenous constituents by the previously described magnesium sulphate precipitation method. Accordingly, a large number of glues and gelatines were analyzed for their protein, proteose, peptone and amino acid content. Those analyzed included all of the standard grade

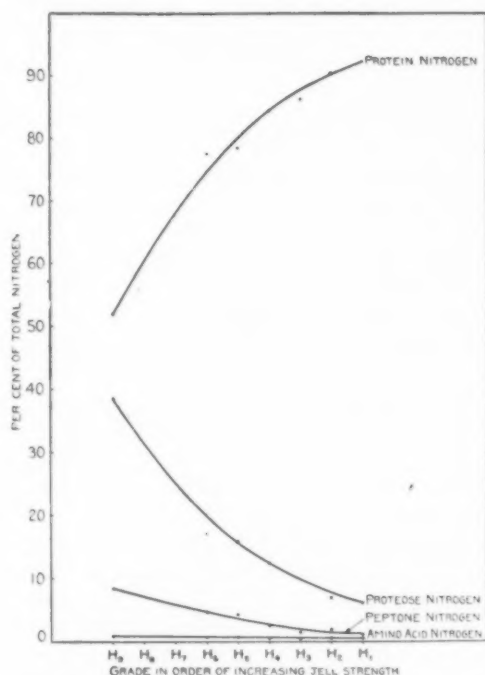


FIG. 15. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH, HIDE GLUES

glues, Russian isinglass from sturgeon sounds, an edible gelatine, fish glue, peptone and several other series of glues.

The results of all of these analyses show a most clear-cut relation to exist between these nitrogenous constituents and the jell strength, which may be summarized as follows:

The protein nitrogen varies directly as the jell strength.

The proteose and peptone nitrogen vary inversely as the jell strength.

The amino acid nitrogen shows a slight tendency to vary inversely as the jell strength.

The amino acid nitrogen is higher in bone glues than in hide glues and fleshings.

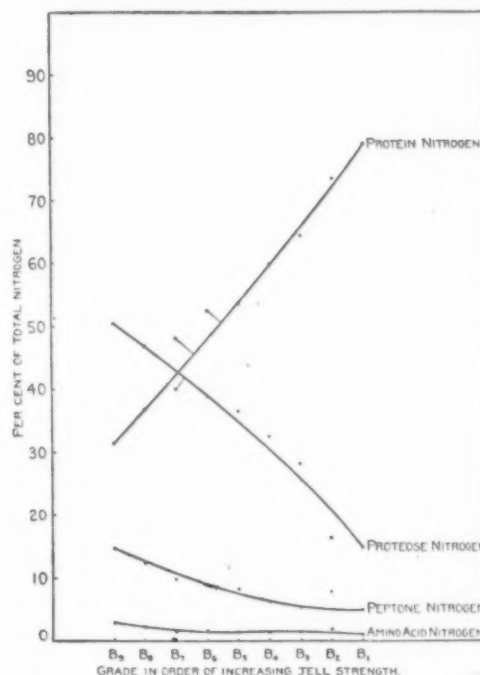


FIG. 16. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH, BONE GLUES

The jell strength of a glue is therefore determined by and is probably absolutely dependent upon the ratio of its protein nitrogen to its products of hydrolysis, chief among which is the proteose nitrogen.

The data of this set of determinations are given in Table XXXII. The figures represent the percentage of the total nitrogen which is precipitated. The graphical representations of the results are shown in Figs. 15 and 16.

TABLE XXXII. RELATION BETWEEN NITROGENOUS CONSTITUENTS AND JELL STRENGTH

	Grade	Protein N	Proteose N	Peptone N	Amino Acid N
Hide glues and fleshings	H1	92.2	6.3	1.1	0.4
	H2	90.4	7.0	2.0	0.6
	H3	86.2	12.0	1.4	0.4
	H4	84.6	12.4	2.6	0.4
	H5	78.7	16.0	4.5	0.8
	H6	77.6	17.0	4.7	0.7
	H7	52.0	38.6	8.4	0.9
	B1	79.1	14.9	4.8	1.2
	B2	73.5	16.4	8.1	2.0
Bone glues	B3	64.6	28.3	5.6	1.5
	B4	59.8	32.4	6.4	1.4
	B5	53.6	36.6	8.4	1.4
	B6	52.5	37.9	7.8	1.8
	B7	48.2	40.1	10.1	1.6
	B8	36.8	47.1	12.5	2.3
	B9	31.5	50.6	14.8	3.0
Special glues:					
Russian isinglass	H2+	91.0	4.4	4.5	0.1
Edible gelatin	H3+	87.8	11.3	0.7	0.2
Fish glue	B9	33.4	42.3	21.9	2.4
Pressure tankage	B9	34.3	46.4	16.3	3.0
Peptone	B9	0.0	33.2	48.5	18.3

In order to note if the variation in protein content as determined by precipitation in a half-saturated solution of magnesium sulphate would persist if the effect of viscosity were cancelled, a series of five glues of equal viscosity but varying jell strength were analyzed for protein nitrogen.

It was found that the protein nitrogen varied directly as the jell strength, regardless of the uniformity in viscosity, as is shown in Table XXXIII.

TABLE XXXIII. RELATION BETWEEN PROTEIN NITROGEN AND JELL STRENGTH

Jell Strength	Viscosity	Protein N
63	46.2	83.5
64	45.8	84.2
66	46.0	84.9
68	45.8	85.3
70	46.2	85.5

RELATION OF NITROGENOUS CONSTITUTION TO VISCOSITY

Several series of glues were studied to ascertain if any relation existed between the nitrogenous constitution of glue and viscosity. Each series consisted of several glues of uniform jell strength and varying viscosities.

Although the greatest care was used in the elimination of sources of error, the results obtained do not show

TABLE XXXIV. RELATION BETWEEN NITROGENOUS CONSTITUTION AND VISCOSITY

	No.	Grade	Viscosity	Jell	Protein N	Proteose N	Peptone N	Amino Acid N
Series 1	1	H ₄	47.0	---	73.8	19.2	6.58	0.42
	2	H ₄	48.0	---	78.6	15.1	6.30	0.00
	3	H ₄	49.0	---	75.3	22.0	2.70	0.00
	4	H ₄	50.0	---	75.4	19.8	4.66	0.14
	5	H ₄	51.0	---	72.9	22.3	3.54	1.26
	6	H ₄	52.0	---	72.9	21.1	5.12	0.88
	7	H ₄	54.0	---	72.2	21.8	4.60	1.40
Series 1	8	B ₂	46.0	---	71.1	21.1	6.40	1.40
	9	B ₂	47.0	---	63.8	26.0	7.88	2.32
	10	B ₂	48.0	---	---	---	6.18	3.92
	11	B ₂	49.0	---	60.6	30.9	6.29	2.21
	12	B ₂	50.0	---	---	---	5.91	3.49
Series 3	1	H ₄	45.6	65	84.4	10.8	3.7	1.1
	2	H ₄	47.2	65	87.3	8.9	2.6	1.2
	3	H ₄	48.0	66	87.0	8.8	2.6	1.6
	4	H ₄	49.0	66	85.2	10.4	3.8	0.6
	5	H ₄	50.2	66	85.2	10.7	3.5	0.6
	6	H ₄	51.0	64	84.9	11.1	3.2	0.8
	7	H ₄	55.0	64	81.8	12.6	4.6	1.0
Series 3	8	B ₂	43.2	68	75.6	16.1	7.0	1.3
	9	B ₂	45.8	70	77.0	14.4	6.3	2.3
	10	B ₂	47.0	70	77.5	14.1	6.5	1.9
	11	B ₂	48.0	70	76.2	15.3	6.3	2.2

any consistent relation to exist between these nitrogenous constituents and viscosity.

SUMMARY UPON CHEMICAL CONSTITUTION

There appears to be no relation between the proximate constitution of glues and their jell strength and viscosities, except that the water content of the air dry glue is proportional to the jell strength. This means that the water-retaining capacity of glues and gelatines is controlled by the same factors as determine the jell strength, which, as has been shown, is the ratio of protein to its products of hydrolysis.

The jell strength varies directly as the protein nitrogen, and indirectly as the proteose and peptone nitrogen in all glues and gelatines.

The amino acid nitrogen is greater in bone than in hide glues, and tends slightly to increase with decrease in jell strength.

If the jell strength remain constant, the variations in viscosity are not traceable to variations in the ratio of the protein to its products of hydrolysis: proteose, peptone, and amino acids.

INFLUENCE OF SIZE OF MOLECULE UPON PHYSICAL CONSTANTS

It has been noted in a previous paper²² that viscosity and jell strength are functions of the melting point.

²²See Part II.

Assuming that the several grades of glues are essentially of the same original composition, differing only in the extent of the hydrolysis which they have undergone, it seems reasonable to expect that the melting point will be determined primarily by:

The resultant of the melting points of the several nitrogenous constituents, protein, proteose, peptone, and amino acids.

The resultant of the melting points of the variously sized molecules which constitute the several products of hydrolysis.

As to the first of these, we know that the protein gelatin possesses a higher melting point than its products of hydrolysis. We should therefore expect that in glues the melting point would vary directly as the grade (since we have found that "grade" or jell strength is a function of the protein content)²³.

This we know to be the case, since, in general, the viscosities vary as the jell strength²⁴ and viscosity is a function of the melting point²⁵.

With regard to the second of the possible causes for variation in melting point, it seemed probable that within any one group as protein, or proteose, the molecules constituting that group might vary considerably in size. (The ultimate molecule is referred to here, and not the aggregate of molecules going to make up a colloidal complex, which is even more subject to change. The writer differentiates these conditions by maintaining the molecule to be a group which may not be subdivided except by chemical processes, as of hydrolysis, whereas the colloidal complex is established probably by electrical phenomena and the processes of chemical condensation or hydrolysis are not involved.) This seems especially plausible since the line of division between the several groups is a very arbitrary one, depending solely upon their relative solubilities in salt solutions. So, for example, the "protein" consists of all those molecules which are sufficiently large to be insoluble in and precipitated by a half saturated solution of magnesium sulphate²⁶. But it may be presumed that these large molecules may vary greatly in size. The protein fraction of one glue may have a large proportion of its molecules of great size, and another glue of size just sufficiently large to be precipitated. In such a case, especially when the protein fraction includes three-quarters or more of the total organic material of the glue²⁷, such variation in the size of its constituent molecules would certainly be expected to reveal itself by like variations in melting point and hence in viscosity.

This hypothesis was tested by subjecting a number of glues of uniform jell strength and varying viscosities to precipitation by less than half-saturated solutions of magnesium sulphate. It was assumed that as the strength of the salt solution was decreased, the minimum size of those protein molecules which were thrown down would be progressively raised, so with the lowest concentration of salt only the largest molecules would come down. Magnesium sulphate concentrations of from 50.0 per cent down to 24.0 per cent of saturation were used. Below 24.0 per cent, the precipitate was so finely divided and slimy as to render filtration practically impossible. The data of these determinations are given in Table XXXV.

²³See p. 107.

²⁴See p. 64.

²⁵See p. 64.

²⁶Schryver, "Allen's Commercial Organic Analysis," vol. 8, p. 467, *et seq.*

²⁷See p. 107.

TABLE XXXV. RELATION OF SIZE OF MOLECULE TO VISCOSITY
Showing per cent of nitrogen thrown down by varying percentage saturations of magnesium sulphate

No.	Grade	Jell	Visc.	50 per Cent	35 per Cent	30 per Cent	28 per Cent	25 per Cent	24 per Cent
Series 3									
1	H ₄	65	45.6	84.4	69.2	41.3	.....	.....	.....
2	H ₄	65	47.2	87.3	68.8	46.0	.....	.....	.....
3	H ₄	66	48.0	87.0	71.8	49.7	.....	.....	.....
4	H ₄	66	49.0	85.2	71.6	50.3	.....	.....	.....
5	H ₄	66	50.2	85.2	68.0	51.7	.....	34.6	28.6
6	H ₄	64	51.0	84.9	68.0	52.2	.....	35.3	29.0
7	H ₄	64	54.0	81.8	64.8	50.9	.....	34.8	30.0
8	B ₂	68	43.2	75.6	.....	22.3	.....	.....	.....
9	B ₂	70	43.8	77.0	.....	36.3	.....	.....	.....
10	B ₂	70	47.0	77.5	.....	38.9	.....	.....	.....
11	B ₂	70	48.0	76.2	.....	39.8	.....	.....	.....
Series 4									
1	H ₄ +	64	45.4	81.8	58.2	44.2	39.2	.....	.....
2	H ₄ +	64	47.4	87.3	68.8	46.0	42.1	.....	.....
3	H ₄ +	64	50.6	74.0	60.6	49.2	45.8	.....	.....
4	H ₄ —	65	46.2	85.4	62.9	47.3	39.5	.....	.....
5	H ₄ —	65	47.8	87.2	65.1	46.6	40.9	.....	.....
6	H ₄ —	65	48.0	75.6	57.6	44.7	44.7	.....	.....
7	H ₄ —	65	49.4	76.5	59.0	47.2	45.3	.....	.....
8	H ₄	65½	49.0	72.2	59.0	44.5	42.0	.....	.....
9	H ₄	65½	50.0	86.0	66.9	52.8	44.0	.....	.....
10	H ₄	65½	50.2	85.2	66.4	52.1	48.7	.....	.....
11	H ₄ +	66	47.4	83.0	63.1	47.7	42.5	.....	.....
12	H ₄ +	66	48.6	87.0	71.8	49.7	46.1	.....	.....
13	H ₄ +	66	48.8	85.2	71.6	50.3	46.1	.....	.....
14	H ₄ +	66	49.2	86.2	64.3	52.2	46.8	.....	.....
15	H ₄ +	66	49.6	85.2	68.0	51.7	49.0	.....	.....
16	H ₄ +	66	49.8	83.2	65.5	52.7	49.4	.....	.....

An examination of the data will show that at the low concentration of 28.0 per cent to 30.0 per cent of saturated magnesium sulphate, except in one instance where it was necessary to go as low as 24.0 per cent, the nitrogen thrown down in the several precipitates varies directly as the viscosity, the jell strength being

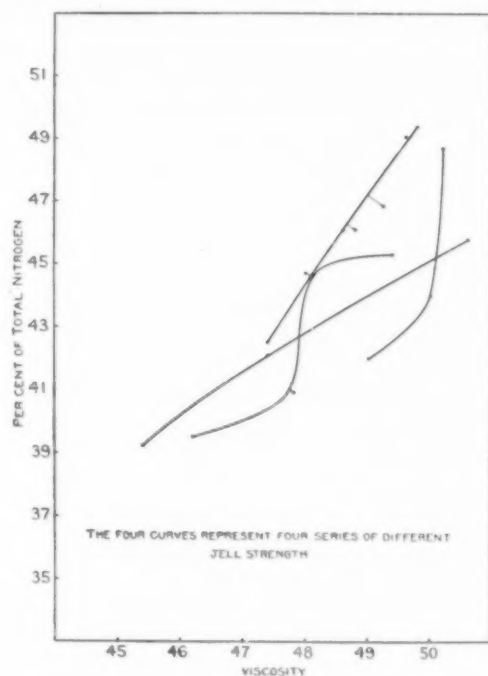


FIG. 17. THE RELATION OF NITROGEN PRECIPITATED BY 28 PER CENT SATURATED $MgSO_4$ TO VISCOSITY

uniform. This means that if the jell strength be constant the viscosity will vary as the size of the protein molecules.

The results from the precipitation by 28.0 per cent saturated magnesium sulphate solution are expressed graphically in Fig. 17.

It had been observed that if the viscosity were constant the jell strength would also vary as the melting point.²⁶ To further study the reason for this, a number of glues of uniform viscosity and varying jell strength

were treated with 50.0 per cent and 30.0 per cent saturated magnesium sulphate and the precipitates Kjeldahled as before for nitrogen. The results are given in Table XXXVI.

TABLE XXXVI. RELATION OF SIZE OF MOLECULE TO JELL STRENGTH

No.	Jell	Viscosity	50 per Cent	30 per Cent
1	63	46.2	83.5	45.0
2	64	45.8	84.2	46.2
3	66	46.0	84.9	46.7
4	68	45.8	85.3	55.1
5	70	46.2	85.5	57.4

It will be seen that at both 50.0 per cent and 30.0 per cent magnesium sulphate saturations, the nitrogen thrown down in the several precipitates varies directly as the jell strength, the viscosities being practically constant. This means then that at constant viscosity the jell strength will vary as the size of the protein molecule, as well as with the total amount of protein.

It seems, therefore, in the light of this set of experiments that:

The melting point, and therefore the viscosity, of a glue is determined *normally* by the balance between its protein content and that of its hydrolyzed products, but

At any given uniform jell strength, the melting point and viscosity will depend upon the ratio of large to small sized molecules within the protein group.

The positiveness of the above results makes it appear improbable that variations in size of molecule within the other groups would be of sufficient influence to seriously modify the effects noted above. This is to be expected; for

The amounts of the other groups present in normal glues is nearly always small in comparison with the protein group,²⁶ and

As the size of the molecules decreases, their effect on melting point and viscosity likewise diminishes, so that a much larger amount would be necessary to produce an equivalent effect.

(Part IV will be published in a subsequent issue.)

Vegetable-Oil Industry in Japan

According to the latest available statistics, the exports of various vegetable oils from Japan for the first nine months of 1919, compared with those of the whole of 1918, are as follows:

Kind of Oil	January-September, 1919		Total, 1918		Exports to America, 1918	
	Lb.	Value	Lb.	Value	Lb.	Value
Cocoanut...	21,134,967	\$2,757,046	53,950,258	\$6,846,732	49,244,641	\$6,216,924
Soya bean...	3,170,323	348,115	6,570,957	754,800	5,225,784	601,126
Cottonseed...	947,443	141,307	2,446,397	301,175	1,189,211	138,614
Camphor...	666,967	59,198	1,827,825	133,633	1,057,307	70,577
Peppermint...	438,179	485,140	286,180	274,033	8,368	6,450

The center of the oil-crushing industry is Kobe. The majority of the mills employ the pressure method of oil extraction, using one of three types of hydraulic-pressure machinery: (1) The round-bed type, with a bed about 18 in. in diameter, used for beans and rape-seed; (2) the oblong, flat-bed type, about 30 x 14 in., used for pressing copra; and (3) the bowl type, in which a stone bowl is pressed into a mass of seed pulp held by iron hoops, used in second and third pressings of peanuts and beans. One mill is reported as using an American rotary-type screw expressor, and a few have adopted the benzine-extractor process. Nearly all the mills can crush any kind of vegetable-oil seeds by a slight adjusting of the machinery.

²⁶See p. 107.

The Application of Copper-Refining Practice to Other Fields

BY LAWRENCE ADDICKS

ELECTROLYTIC refining has attained its chief application and highest development in the metallurgy of copper. The very dynamo, the invention of which created the large-scale demand for high-conductivity copper, gave the means of producing it by electro-deposition, and electrolytic refining on a commercial scale was one of the first electrical industries to be developed, while it remains today by far the largest application of the electrolysis of an aqueous electrolyte.

The experience gained in this field has found wide application in the refining of other metals, such as silver, gold, lead, bismuth, tin, nickel, iron and zinc, and in the recovery direct from the ore by leaching of copper, silver, gold and zinc. The successful application of electrolysis to these different fields requires a rebalancing of the various factors discussed in previous articles by the author, the relative values of which are often greatly altered by a change of metal. In any given case we must take into account (1) competition from other processes, (2) acid radical to be employed, (3) temperature of electrolyte, (4) character of deposit, (5) resolution at the cathode, and (6) depolarization at the anode.

COMPETITION

Electrolytic copper refining has no effective competitor in its own field. Fire refining makes a low conductivity product unless furnished with very pure raw material such as selected Lake "mineral," and the various selective methods of reverberatory treatment yield but a partial recovery of gold and silver.

In the leaching field electrolysis has to meet several competitive methods of reduction, notably precipitation upon iron. While a free acid equivalent by electrolyzing is returned to the cycle, there are usually serious handicaps imposed by large quantities of impurities which cause various troubles in the cells and which progressively accumulate unless some outlet is provided. Even where electrolysis is indicated, therefore, an iron precipitation plant is usually required as an adjunct, from 10 to 30 per cent of the copper being recovered as cement.

Electrolytic silver has to compete with the older sulphuric acid method of parting. The latter is easy to operate and ties up less silver, but it will not make a product so low in gold as the electrolytic. It is still indicated, however, for small plants or for those which are used spasmodically.

In the case of gold refining the question is almost wholly dependent upon the amount of platinum and associated metals present. If the original gold is free from this metal group, there is no object in tying up the gold several days for electrolysis and further increasing the opportunities for theft. When but very small quantities of platinum and palladium are present, they may be satisfactorily collected by wet methods instead of by electrolysis at about equal expense. When the quantities are larger electrolysis is indicated.

Electrolytic lead has to compete with the very efficient Parkes process of refining. When all factors are considered, the justification for electrolysis appears to rest almost entirely upon the quantity of bismuth present in the bullion to be treated. This objectionable

impurity is not satisfactorily removed by the Parkes process and special treatments such as Pattisonizing are expensive, while the electrolytic method readily separates the bismuth from the lead and converts it into a marketable byproduct.

Nickel, iron and zinc may be readily refined by electrolysis, but in ordinary times the value of the refined product, except in a very limited quantity, is not sufficiently above that of the crude to pay for the refining. Tin offers a special field for impure ores which are difficult to handle by fire processes.

In leaching, both nickel and zinc have strong competition from chemical and pyrometallurgical processes and this whole field is still in a state of flux.

In general, we can say that electrolysis enjoys no such absolute monopoly in other fields as it does in copper refining and that each proposed application must, therefore, receive full consideration upon its merits.

ACID RADICAL

While several salts of copper are suitable for electrolytic treatment, the sulphate possesses so many practical advantages that it is universally employed. The first requirement for an electrolyte is that the salt of the metal employed shall be readily soluble. The second is that the material which it is desired to collect in the slime shall be insoluble in it. The third is that the cathode should not be redissolved by the electrolyte. Copper sulphate is a readily soluble salt and copper; gold and silver are all practically unattacked by dilute sulphuric acid.

When electrolyzing silver a nitrate electrolyte is employed, as silver sulphate is not a readily soluble salt. The amount of free acid carried is necessarily low, as nitric acid is expensive and decomposes under the conditions of electrolysis. Copper concentrates in the electrolyte and is removed by withdrawals, while gold remains unattacked in the slimes.

In gold refining a chloride electrolyte is employed. Gold chloride is a soluble salt, platinum concentrates in the electrolyte, and although silver, being less noble than gold, dissolves at the anode, after saturation it precipitates as a secondary slime of insoluble chloride.

For lead, chloride and acetate were first tried, but not until Betts developed the fluosilicate electrolyte was the electrolytic refining of lead made a commercial success.

It will, therefore, be appreciated that an entirely new set of chemical conditions as regards behavior of impurities, etc., is encountered with every metal refined.

TEMPERATURE OF ELECTROLYTE

While it is customary to heat copper electrolytes externally, quite opposite conditions obtain in the case of silver, lead and zinc. Nitric and hydrofluosilicic acid show increasing decomposition losses with rise in temperature, asphalted tanks do not stand hot liquors and zinc resolution losses must be limited. In the case of silver, the current may have to be limited to control the temperature; for lead, extraneous heating is abandoned, and with zinc, where the specific resistance of the electrolyte is high, cooling systems carrying circulating water must be employed.

CHARACTER OF DEPOSIT

At moderate densities copper readily gives a good adherent deposit. The same may be said of gold. Silver gives normally a loose crystalline deposit. Nickel is

nodular, while lead and zinc tree very badly. By the proper use of addition agents all of these deposits may be made smooth and coherent. In fact it was not until the value of addition agents was more or less understood that lead could be handled at all.

In the early copper plants a great deal of trouble was had in getting good starting sheets, and it was thought that the addition of ammonium sulphate was a help, the use of double salts being common practice in various electroplating prescriptions. Then the beneficial effect of the presence of wood strips on the edges of the starting blanks led to the introduction of wood tea made from shavings, yielding a complex organic addition agent. Finally the remarkable results following the addition of gelatine were worked out. The irregularities of early practice were due to overdosing and a failure to appreciate the fleeting effect of a single dose. Today a few pounds of common glue dissolved in water and added regularly throughout the twenty-four hours, together with a can of ordinary engine oil, will control the deposit in the tank house of a great copper refinery, permitting the use of higher densities, closer spacing and greater cathode age.

For silver, while adherent deposits can be made in similar fashion, it is customary to collect the silver crystals as such, either brushed to the floor of the tank from vertical cathodes by mechanical scrapers as in the Moebius system or shoveled by hand from the horizontal carbon cathode of the Thum cell. These crystals are readily washed free of electrolyte and fed to retorts for melting.

Lead may be beautifully controlled by addition agents. The exact amount to be added varies from time to time and is determined by experiment and careful watching of the fresh deposit on special strips hung for the purpose.

Zinc is generally plated in coherent form on an aluminum cathode, from which it is peeled every forty-eight hours. There is no reason why zinc starting sheets could not be used as in the case of copper, and in some ways the avoidance of a zinc-aluminum couple would be of advantage. In the development of electrolytic zinc practice, however, there has been great difficulty in controlling resolution at the cathode, and the great advantage of using aluminum sheets lies in the fact that strong corrosion can do no more than leave the starting sheets bare, whereas were they of zinc they might be completely eaten through, causing collapse, open circuits, general demoralization and shut-down of the plant.

RESOLUTION AT CATHODE

The cathode is never absolutely insoluble in the electrolyte used and a small amount of reoxidation is always in process. In the case of copper with normal electrolytes it is a minor matter—perhaps 2 per cent. Should we allow an accumulation to take place of salts of manganese, iron or any other metal capable of alternate oxidation and reduction at anode and cathode with change of valence, a very serious condition may arise.

In these days copper anodes are so highly refined that the amount of iron contained in the electrolyte is quite negligible, but when electrolyzing liquors arising from the leaching of ore a very different situation exists. Such liquors commonly contain large quantities of ferrous sulphate and a certain proportion of ferric sulphate. Oxidation at the anode tends to increase the latter at the expense of the former. (See Addicks, *Trans. Am. Electroch. Soc.*, vol. 28, p. 87.) Experiments show

that 0.25 per cent of iron as ferric sulphate in an electrolyte sufficiently agitated will corrode cathode copper at a rate which will require a current corresponding to about 8 amp. per sq.ft. merely to replace the loss. The proper control of ferric sulphate is, therefore, the key to success in electrolyzing copper leaching liquors.

Another interesting example of resolution is in the case of zinc—in fact this is the controlling factor in zinc electrolysis. In the electrolysis of zinc sulphate using an insoluble anode the content of free sulphuric acid gradually increases and unless the cathode is absolutely pure zinc resolution is very active. Perfectly pure zinc is so nearly insoluble in sulphuric acid that it is quite difficult to get it in solution for analysis. But if a nodule of cathode zinc is immersed in dilute sulphuric acid in a test and the nearest trace of almost any impurity is added, a vigorous evolution of hydrogen will start at once. This is probably due to galvanic action, and the whole secret of successful zinc electrolysis lies in the passivity of pure zinc in sulphuric acid. This calls for a degree of purity in the electrolyte which would be quite uncommercial were it not for the fact that zinc dust readily throws down most of the impurities to be dealt with after the liquor from the leaching tanks has been neutralized. The last traces of some difficult elements, such as arsenic, are removed by adsorption upon freshly made ferric hydrate.

DEPOLARIZATION AT THE ANODE

Anode efficiency plays a relatively small part in normal copper refining; the proportion of impurities present in the anode is small and the useful anode efficiency very high. As soon as a complex or insoluble anode is substituted, however, the oxidizing effect of the current is in part or in whole employed in the solution of anode impurities, the oxidation of suitable salts in the electrolyte or in the decomposition of water with escape of oxygen as such. This introduces several new problems.

A moderate amount of an oxidizable impurity, such as nickel, in a copper anode gives the first and simplest case. The nickel and copper dissolve proportionately at the anode, sharing the current. At the cathode, however, only copper is deposited, so that the copper in the electrolyte is correspondingly depleted. About 2 per cent of the copper deposited is restored by purely chemical solution at the electrodes but beyond that figure soluble copper must be added by leaching shot or scale, and the accumulating nickel must be controlled by withdrawals to a byproduct plant.

The second difficulty arises when the quantity and nature of the impurity in anode causes segregation into two components one of which is more readily dissolved than the other. Then the anode disintegrates unevenly and a large amount of scrap has to be reworked.

A third and more serious condition is met with when the impurity is insoluble, such as lead or antimony, when the anode will become coated with a non-conducting slime. The voltage will then rise until some free oxygen is generated from the moisture underneath. This in turn will burst through the coating and the anode will act normally for a few seconds, when the coating will again form. A voltmeter connected across such a tank will show a wildly fluctuating needle, and this condition, known colloquially as "crazy tanks," is fatal to good refining, entailing as it does excessive gold and silver losses in the cathode, high power cost and a heavy expense for purifying electrolyte. The remedy lies in

properly refining the crude material before casting the anodes.

Finally, we have the extreme case where the anode is by intent insoluble, as where copper is being recovered from leaching liquor. Where no depolarizer is employed, the voltage must of course be sufficiently high to decompose water, and free oxygen is given off at the anode. When the liquor is virtually free from chlorides and nitrates, antimonial lead is generally used as the anode material; when electrolyzing zinc, however, pure lead is required in order not to poison the cathode with specks of antimony. When the liquor is corrosive, either magnetite or one of the ferro-alloys, generally ferro-silicon, is employed. None of these anode materials is wholly free from oxygen attack. Lead peroxidizes and sulphatizes and the iron alloys slowly dissolve, so that a certain replacement charge must be reckoned with.

Where an efficient depolarizer is employed, any of the materials mentioned above or carbon may be employed. Graphite offers peculiar advantages in that 100 per cent of efficiency of oxidation of ferrous sulphate or similar depolarizer is readily obtained by its use. Lead does not give equal results. On the other hand carbon itself will oxidize and disintegrate if not fully protected by the depolarizer. This whole question of a cyclic oxidization at the anode with subsequent reduction at the ore contact is yet in but partially developed form, most of the theoretical advantages being generally offset in practice by the difficulties met with in handling impurities dissolved from the ore.

Use of Esparto in Paper Making

During the European war the scarcity of paper pulp in the Spanish market, caused by the difficulty in securing supplies from the sources formerly relied upon, especially the countries bordering upon the Baltic coast, caused Spanish paper makers to consider the use of esparto to supplement the import supply. Esparto grows throughout extensive districts in the south of Spain, and a poorer quality is found on large areas of poor and sandy lands in Algiers and Tunis. Esparto fiber has been used for centuries in Spain, and the manufacture of matting, baskets and cordage exclusively of esparto dates from the time of the Moorish occupation.

EARLY EXPERIMENTS IN THE USE OF ESPARTO

Esparto was used in paper making in Great Britain as early as 1857. The industry met decided success in Scotland and a few years later the manufacture was started in the south of France, the raw materials being obtained from Algiers and Tunis, but it has never reached a prosperous basis in the republic, due to the inability to compete with the local straw papers. The industry in Spain in the regions bordering on the Mediterranean coast dates from 1869.

The greatest development of the esparto industry is still found in Great Britain, where the fiber has been used for making fine writing paper of great whiteness, and to some extent for newsprint, though for the latter purpose at the prices usually current other pulps are cheaper. Papers made from esparto are of great thickness compared to the weight and have the advantage of not shrinking or breaking when exposed to moisture. They have especial adaptability for the manufacture of lithographs. They are easily filled, absorb ink well, and

therefore are particularly adapted for fine printing, especially in color work. Esparto paper is highly esteemed for book making because of its texture and light weight.

INTEREST IN ESPARTO REVIVED PRIOR TO THE WAR

Shortly before the outbreak of the European war Spanish interest in esparto began to be revived. In 1910 the Papelera Española installed an experimental plant to use esparto pulp at Arrigorriaga, adopting the best methods which had been developed in Scotland. Because of the difficulties in securing pulp created by the war this plant was later enlarged and by 1917 a daily production of 2,000 kilos was reached and the following year a daily production of 4,000 kilos. Another enlargement of the plant was started in October, 1918, and in the first months of 1919 the daily consumption of esparto pulp reached 16,000 kilos, from which a yield of 8,000 kilos of paper was secured. Two other important plants were installed in 1916 at Aranguren and Renteria, each with a daily capacity of 10,000 kilos of esparto pulp.

In this way the Papelera Española has sought to reduce the necessity of importation of bleachable foreign pulps. During the war the chief preoccupation was to reach the maximum production in the shortest time. The company is now, however, making plans which will allow the placing of this industry on a permanent basis.

LIMITATIONS OF THE USE OF ESPARTO

Though esparto has exceptional qualities for certain uses in paper making, its fibers are not such as will allow its substitution for all the purposes for which wood pulp is used. The fibers are short and weak. The pulp is best used for filling, and is therefore employed largely in mixtures with longer and stronger fibers. Esparto is not suited for the manufacture of wrapping paper. It can, however, be used in larger proportions than has heretofore been the practice in most other grades, and thus make it possible for the Spanish manufacturers of paper to reduce their demands on the foreign market. In documentary papers and others in which great strength is needed not more than 20 per cent of esparto can be used. In writing papers, where light weight is desirable, esparto pulp can be used in large quantities.

For the cheaper grades, especially those in which incompletely bleached pulp is used, the higher price of esparto will, as a rule, make its substitution for bisulphite pulp impossible.

Denatured Alcohol Formula

The Treasury Department, United States Internal Revenue, has recently published Regulation No. 61 dealing with denatured alcohol. Of the various formulas given, No. 4, on page 97, of this bulletin will probably be the one most generally used, and is made up as follows: To every hundredth part by volume of ethyl alcohol should be added two and five-tenths part by volume of approved benzol, five-tenths part by volume of nitrobenzol, two-tenths part by volume of approved pine oil (steam distilled). The old No. 1 formula using wood alcohol has been suspended because so much of this material is being manufactured into formaldehyde, of which there is an acute shortage. The demand for formaldehyde is due to its use in treating grain for smut.

Some Commercial Heat Treatments for Alloy Steels for Structural Purposes*

A General Discussion of Principles of Heat Treatment, Having Especial Reference to a Nickel : Chromium Steel, the Effect of Time in Complex Heat Treatments, and the Development of Simple Heat Treatments From the Complex

By A. H. MILLER†

ALLOY steels both for tool and structural purposes have had an increasing application for a number of years. The present paper, for its limited purpose, will be confined to a discussion of steels for structural purposes, and will further limit itself to their heat treatment. It will apply directly to the two alloy steels which are probably used to a greater extent than all others combined—namely, nickel and nickel : chromium steels. It is to be borne in mind, however, that the statements to be made in regard to these two alloys are almost equally applicable to all of the structural alloy steels, provided temperature changes are made which correspond to the changes in the critical temperature of these alloys.

In speaking of heat treatments, a fundamental thought must always be held in mind, which is this: All fabricated steels have submitted to a heat treatment. The difference between steels known as heat treated and others commonly spoken of as untreated is merely that the treated steels have supposedly received a preconceived and carefully executed treatment, while the so-called untreated steels have received the variable and generally unknown treatment which is the result of casting, forging and cooling at an unknown and variable rate from the casting or forging temperature.

TIME AT THE HIGH HEAT

In the heat treatment of alloy steels, the three variables which must be controlled for a successful heat treatment are temperature, time and rate of cooling. The influence of mass on these three variables must never be neglected, and it must be borne in mind that an increase in mass may increase the treatment temperature, should increase the length of time held at temperature, and will inevitably alter the rate of cooling.

Too little attention is generally paid to the time element of the heat treatment, whereas it actually is of very great importance. To illustrate this, Figs. 1 to 7 inclusive show a series of photomicrographs of a nickel : chromium steel of composition C 0.35 to 0.40 per cent, Ni 3 per cent and Cr 1.50 per cent, showing the microstructure in a typical forged condition, and after annealing at a proper annealing heat for varying periods of time. It will be noted that this series gives the time held at the annealing temperature from zero (meaning that the piece was brought to temperature and the furnace was immediately shut down) to 10 hr. A study of the photomicrographs shows that the ferrite as contained in the cell outlines of the forged specimen was not dissolved and uniformly diffused until the piece had been held at the annealed temperature for $\frac{1}{2}$ hr. The last

photograph shows that there had been a slight growth of the austenite crystals between the time of completed uniform solution at $\frac{1}{2}$ hr. and the end of the run at 10 hr.

This series also shows that a new cell system may grow in steel simultaneously with the breaking up of the previously existent system. The pieces were all cut from the same bar, and were treated by placing all together in a furnace controlled by a thermocouple, withdrawing them one by one at the end of the specified time, plunging each immediately into a box of well aerated lime.

The reason that a considerable length of time is required to produce a uniform structure is probably as follows: After the steel is raised to a temperature above the critical temperature, the iron is in the gamma form, in which the ferrite is soluble. There is, however, a certain length of time required for this solution, and, more than that, a certain added length of time is necessary to allow the solution to become homogeneous; just as, in dissolving a lump of sugar in water, a certain length of time is required to complete the solution, and a certain further length of time for the water to become uniformly sweet. If the iron carbide should be dissolved in the gamma iron, but this solution not have had time to become homogeneous before it be recooled, ferrite will naturally separate out on cooling at the point where the greatest concentration existed in the solution.

COMPLEX HEAT TREATMENTS

The object of alloy steel heat treatment and indeed, with a very few exceptions, of all heat treatment is to produce a grain size as small as possible, with a degree of hardness suitable for the purposes intended, by the simplest possible means. Thus the ill-controlled and generally very poorly-forged structure must first be broken up, and a fine uniform structure established. In steels which are sensitive to heat treatment, of which the nickel and nickel : chromium steels are excellent examples, this object is best achieved in several steps, each of which is designed to break up the structure resulting from the previous step and to bring the material into a more nearly ideal condition.

If the forging conditions are bad, as is the case in most forging processes, especially that of drop forging, a treatment of numerous steps may be necessary. As an example of the most drastic I give the following:

- First. Anneal from approximately 1,450 deg. F.
- Second. Quench from 1,600 deg. F.
- Third. Quench from 1,400 deg. F.
- Fourth. Draw at 1,250 deg. F.
- Fifth. Quench from 1,400 deg. F.
- Sixth. Draw at such a temperature as will give the desired hardness.

*Read before the Washington Section, American Society of Mechanical Engineers, March 31, 1920.

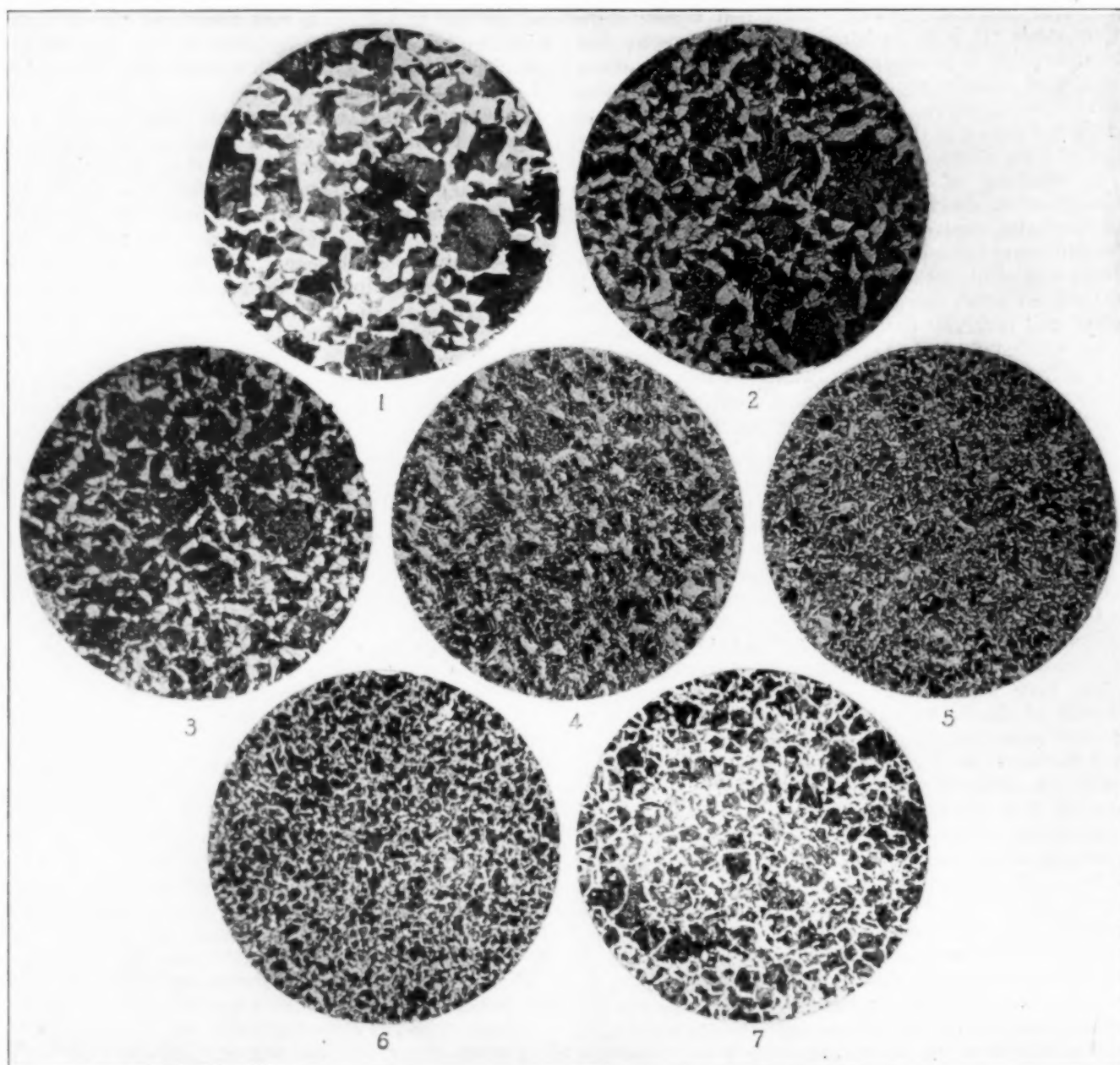
†Bureau of Research, Midvale Steel & Ordnance Works.

This heat treatment is not of unheard length, as it is quite conceivably necessary in many cases. As a matter of fact, in manufacturing pieces which will not subsequently be forged by the purchaser, steel companies very frequently give all of the preliminary steps of this treatment to their regular product. It must be well understood, however, that this number of steps is necessary only to guard against lack of uniformity, due to one piece out of a great number having possibly been subject to a poor forging heat. If the forging temperature can be accurately regulated many of the steps in this treatment can be eliminated.

In much commercial work, with good forging practice, a simple anneal at 1,450 deg. followed by a quench just above the critical temperature and a draw will put the steel in excellent preliminary condition, at which point the steel can be machined to its final shape. If conditions are such that the steel must be extraordinarily hard (as in automobile gears) a final quench with a draw at about 400 to 600 deg. F. is given.

It must be borne in mind when laying out treatments that the time at which the steel is held at temperature during any treatment, whether it be an anneal or a quench, is of quite as great importance as the temperature. This is illustrated by photomicrographs of two pieces cut from the same bar as those previously shown, both of which were placed in the furnace together. One of these pieces (Fig. 8) was drawn from the furnace, and quenched immediately it had reached the quenching temperature (in this case 1,400 deg.). The other, Fig. 9, was allowed to remain in the furnace for $\frac{1}{2}$ hr. and was then quenched. It will be seen that the ferrite areas in the first case had been slightly or completely broken up, whereas in the second case they were very completely dissolved. Again Fig. 10 shows the fine grain resulting from a proper complex treatment.

These photomicrographs differ from a corresponding one in the first series of annealed samples in that there is shown no new grain growth within the old partially broken up system. This, of course, is due to the fact that



FIGS. 1 TO 7. EFFECT OF TIME AT NORMALIZING HEAT (1,450 DEG. F.) FOLLOWED BY SLOW COOLING
Fig. 1. As forged. Fig. 2. Not held, cooled in lime. Fig. 3. Held 5 min. Fig. 4. Held 10 min. Fig. 5. Held 15 min.
Fig. 6. Held 30 min. Fig. 7. Held 10 hr. $\times 80$.



FIG. 8.
Heated to 1,400 deg. F.
Not held, quenched in oil.
Reheated to 1,150 deg. F.
Held 30 min.
Cooled slowly. $\times 100$.

FIG. 9.
Heated to 1,400 deg. F.
Held 30 min.
Quenched in oil. $\times 100$.

FIG. 10.
Heated to 1,450 deg. F. for 30 min., cooled slowly.
Heated to 1,600 deg. F. for 30 min., cooled slowly.
Heated to 1,400 deg. F. for 30 min., cooled slowly.
Heated to 1,150 deg. F. for 30 min., cooled slowly.
 $\times 100$.

in the second case the time element which is necessary for the separation of the ferrite during cooling was not sufficient.

PHYSICAL PROPERTIES POSSIBLE

As a result of a careful heat treatment of nickel : chromium steels Fig. 11 shows a series of curves, showing physical properties of a nickel : chromium steel resulting from proper preliminary treatment and varying drawing temperatures.

The type composition only is given on this curve, because it is a mean of the results of about twenty bars from several heats of slightly varying compositions. The nickel steels of the same approximate carbon content give results which are somewhat inferior to this nickel : chromium curve, whereas the results of another type of nickel : chromium steel, of $3\frac{1}{2}$ per cent Ni, $1\frac{1}{2}$ per cent Cr would be slightly superior to that just shown.

Starting from the extended heat treatment which we have just seen, the development of the cheapest and simplest treatment which will give good results is a matter of intelligently eliminating or altering steps of the ideal heat treatment as conditions permit. For instance, in a certain case which has come to my attention, one in which important drop forgings are manufactured from the grade of nickel : chromium steel shown on the curve, the actual treatment to which pieces were subjected is as follows: The pieces were forged under a drop hammer, and were dipped immediately afterward into a tank of oil which was situated close to the forge. The pieces were kept in this oil for about 4 min., being removed at a temperature between 700 and 900 deg. F. and then buried in ashes as a precaution against cracking. After this the pieces were subjected to a single quench at 1,400 deg. and were drawn at 1,200 deg. They were machined in this condition

and received no further treatment. The uniformly excellent results obtained (each of the pieces was separately tested) showed that this very simple treatment had been entirely effective. A little thought will show that the reason for this was that the drop forging was not excessively high, and that the growth of large cell outline was prevented by the quench after forging was completed. The single quench and draw were sufficient to completely refine the steel from the fair condition which was thus produced.

There is this to be observed in all cases of quenching of alloy or indeed any other steels: Following the quench, the piece quenched is in a condition of great strain and is liable to crack. This liability to crack persists until the piece has been drawn, and it is therefore wise to draw the piece as soon as possible after the quenching.

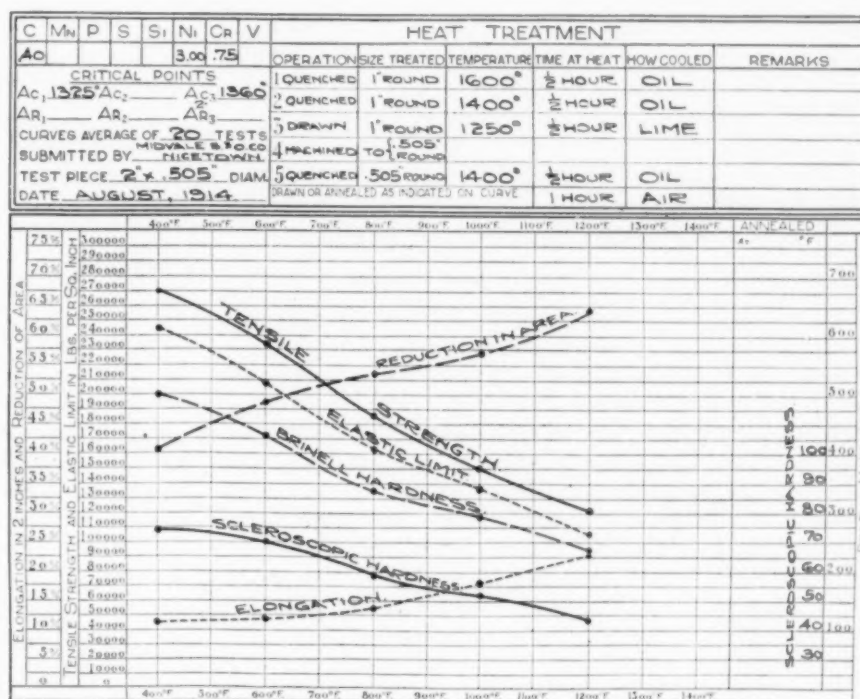


FIG. 11. PHYSICAL PROPERTIES OF A NICKEL : CHROMIUM STEEL RESULTING FROM PROPER PRELIMINARY TREATMENT AND VARYING DRAWING TEMPERATURES

In cases where a drastic quench is advisable it is better to remove the piece from the quenching medium before it becomes entirely cold. By this procedure, the great proportion of the condemnations due to cracking is avoided.

RELATION OF FIBROUS FRACTURE TO SHOCK RESISTANCE

One of the significant effects of a correct heat treatment on alloy steels, which is indeed a criterion as to the efficiency of the treatment, is the production of a peculiar type of fracture in a broken piece, known as "fiber." This fiber fracture is absolutely distinctive, and cannot be mistaken by one who is even slightly skilled in inspection.

It is produced in all of the well melted shock-resisting alloy steels by proper heat treatments, and is so closely related to impact test values that rejected impact tests can almost invariably be selected from passed impact test bars by the absence of this type of fracture. The ease of producing fiber by heat treatment is a criterion of the value of an alloy for shock-resisting properties. So important is the presence of this fracture that armor plate, which must withstand shock test of the most severe character, is never knowingly shipped without possessing it.

Philadelphia, Pa.

The Coal Industry of Swansea, Wales

Swansea is one of the principal coal-producing centers of Great Britain, as well as one of the leading coal-exporting ports. A large part of the consular district is underlain by the coal fields of South Wales. The coal produced is anthracite, semi-anthracite and bituminous. Swansea is, in fact, the chief anthracite center of Great Britain. It is also the center for the manufacture of patent fuel (briquets and ovoids made from coal dust).

The output of the mines of the district before the war was about 9,000,000 tons for all purposes. The output for 1919, however, was only about 6,500,000 tons. Most of the coal produced in the district is exported to other British ports and to foreign countries. The export (coastwise and foreign) trade of Swansea with its sub-port of Port Talbot for 1913, 1918, and 1919 was, in long tons:

Articles	1913 Tons	1918 Tons	1919 Tons
Coal and coke.....	6,743,640	3,845,407	4,434,922
Briquets.....	1,175,119	1,014,603	1,092,803
Total.....	7,918,759	4,860,010	5,527,725

The quantity of coke exported was negligible.

EXPORT QUANTITIES AND PRICES

The Government Coal Control has limited the coal trade of Swansea in two important ways: It has fixed the maximum domestic prices of coal, the present average retail price being about 45s. (\$10.95 at normal exchange) per ton delivered; and it has fixed the minimum supply of coal to be delivered for domestic use, thereby limiting the quantity available for export. Since the output has fallen off considerably during the past twelve months (owing to strikes, shorter work days and decreased output efficiency of workers), this means that the quantity of coal now available for export from this district is far less than it was in former years. The total amount exported from Swansea and Port Talbot for the month of April, 1920, was 220,000 long tons, according to the customs returns for the two ports.

No control is now exercised over the price of export coal, and the prices have risen enormously owing to

shortage of supply and sharp foreign demand. For instance, the average price of best anthracite coal in October, 1919, was 60s. 6d. (\$14.72 at normal exchange) f.o.b. ship, Swansea; for December, 69s. 1d. (\$16.81); in May, 1920, 85s. (\$20.69). Prices of best steam coal at the same dates were 75s. (\$18.25), 88s. 7d. (\$21.56), and 117s. 6d. (\$28.60). The price to-day for run-of-the-mine grade of soft coal is 107s. 6d. (\$26.16). With freight around 50s. (\$17.17) to French Atlantic ports (Rouen or Bordeaux) and 62s. 6d. (\$15.21) to Genoa, Italy, this would make the c. and f. price on run-of-mine coal at French ports 157s. 6d. (\$38.33 at normal exchange, or \$30 at current exchange for sterling), and 170s. (\$41.37 normal exchange, or \$32.38 current exchange) for Italian ports.

CONTINENTAL DEMAND EXCEEDS SUPPLY

Despite these almost prohibitive prices (greatly enhanced by the adverse French and Italian exchange on London), the Continental demands upon the Swansea coal market far exceed the supply of that market. There is ample tonnage at hand, but vessels have to wait an average of sixteen days before securing a berth at the coal piers, so meager is the supply of coal coming to the pier tips.

In view of this condition, and the slight prospect which those interested see of early improvement, many of the local coal-exporting firms are negotiating or have already negotiated contracts with American coal companies for stocks to supply their Continental customers, the coal to be shipped direct from American to Continental ports.

Market for Chemicals in Finland

The total value of the imports of chemicals into Finland during the years 1913 to 1919 is given in the following table, in marks, with the share of each country in this trade during the years 1913 to 1917 (the normal value of the Finnish mark is \$0.193, but the present foreign exchange cable rate is about \$0.05).

From	1913 Marks	1915 Marks	1916 Marks	1917 Marks	1918 Marks	1919 Marks
Russia.....	204,117	3,628,396	14,999,789	12,113,125		
Sweden.....	127,113	10,651,673	26,748,867	21,489,487		
Germany.....	2,456,262	2,759	652			
Great Britain..	1,853,290	5,050	2,229	5,769		
Italy.....	1,576,393	48				
Belgium.....	780,113	1,000				
Netherlands..	773,299	21	208	5		
Other countries	79,350	86,121	294,818	5,228,532		
Total.....	7,849,939	14,374,949	43,260,712	38,851,144	5,213,157	22,728,126

These chemicals consist of potash, alum, ammonia (salammoniac) and salts of ammonia, potassium nitrate (pure and commercial), Chilean saltpeter, soda, sodium sulphate, borax, chloride of lime, copper sulphate, heavy-spar sulphuric acid, hydrochloric acid, nitric acid, sulphur, phosphorus, arsenic acid, compounds of arsenic, potassium chromate, potassium chlorate, magnesium, sugar of lead, cream of tartar, tartaric acid, citric acid, calcium carbide. In addition to these chemicals, dyes, drugs and tanning materials are extensively used. Germany has been the principal source of the chemical supply. Extracts and tanning materials are imported from England and sulphur from Italy.

Statistics are not available as to the value of the imports by countries for the years 1918 and 1919. It is noteworthy that 1916 is the first year in which there is recorded an import of chemicals from the United States. During 1919 almost the entire supply of sulphur came from the United States; also considerable quantities of tanning extracts and some drug supplies.

When a Workman Overdoes Himself

BY CHESLA C. SHERLOCK

IT IS not at all uncommon for workmen who are intensely interested in their work, or in a great hurry, to overexert themselves or attempt too much and thereby receive injuries which they ordinarily would not incur under normal conditions. Strains, overexertions, ruptures or hernias are all the logical result of such overexertion. These injuries sometimes are as powerful a contributing cause to the workman's incapacity for work as anything that could be called to mind.

Employers are naturally anxious to know what their legal liability in such cases is, particularly in those employments where workmen are peculiarly liable to suffer such strains or overexertion. Industrial accident statistics place the greatest risk from this nature of injury upon factory helpers—those required to move materials from one place to another, or those engaged in so-called "heavy" work.

Then, again, a strain or an overexertion may be due to the fact that the employer has attempted to make his workmen do a task without sufficient help, one so big that it overwhelmed them. The question arises here, Is the employer liable for his failure to furnish sufficient help to accomplish successfully the object he had in mind?

IS STRAIN AN "ACCIDENTAL" INJURY?

The workmen's compensation acts, as most employers know, provide compensation for accidental injuries received arising out of and in the course of the employment. The principal question which has agitated employers and the courts has been whether a strain can be deemed an "accidental" injury.

In a New York case, the Industrial Commission found "that while claimant was working for his employer at his employer's plant, and was assisting another employee in lifting a barrel weighing about 200 lb., he was seized with a stroke of apoplexy by reason of the strain occasioned by the lifting of the heavy barrel. By reason of the apoplexy, that portion of the brain in which the apoplexy was seated degenerated and while the claimant gradually recovered from the motor paralysis of the left side which immediately followed the apoplexy, there remained a deterioration of his mental faculties due to the above-mentioned degeneration, by reason of which apoplexy and degeneration claimant was disabled from working from the date of the accident to the date hereof and is still disabled." The Commission held that this was a compensable accident.

Where death is caused by reason of the strain or the overexertion, the court in Canada has said: "If an accident necessitates an operation and death ensues, even though it is not a natural or probable consequence, the death may, if the chain of causation is unbroken, be said to have in fact resulted from the injury."

HERNIA A CAUSE OF CONTROVERSY

Hernia has always been the subject of much controversy. This is probably due to the fact that medical men are not entirely agreed among themselves as to what causes hernia. There are two theories—one that it must be the result of an accidental breaking down of the abdominal walls due to strain or overexertion, the other that such a hernia is an impossibility and

that it must always be the result of a disease or a predisposition to hernia.

The Iowa Industrial Commissioner has fittingly stated the general rule of law on the subject when he said: "Hernia may or may not be compensable according to the rules commonly observed in various jurisdictions. Compensable hernia results from specific accident or incident involving unusual condition, such as a strain or a fall or other fortuitous experiences which may be definitely described as to time and circumstance, and attended by demonstrations of distress at the time the injury occurs. In cases where hernia is of gradual development, where alleged injury is unattended by distinct incident and at a date that cannot be definitely fixed, and when the workman is able to continue his service, arbitration cannot be encouraged as giving promise of compensation."

One authority has said: "A hernia, in order to be entitled to any indemnity, must appear suddenly, must be accompanied by pain, and must immediately follow an accident. There must be proof that hernia did not exist prior to the accident."

OPINION OF A MEDICAL AUTHORITY

A well-known medical authority has said: "The proviso that the injury to the inguinal region must have been due to direct violence, or that the accident or overexertion to which the hernia is attributed shall have been of a character capable of producing a hernia, needs no explanation. Since there might be much discussion of what produces accidents capable of producing hernia, the more specific statements given are welcome aids: Direct violence, slipping or falling while throwing a heavy weight, extraordinary exertion, whether extraordinary in an absolute sense or extraordinary from the standpoint of the physique or age of the individual, or the conditions under which the work was being performed.

"An industrial hernia is undoubtedly always small when it first appears, and to estimate its maximum size as that of an egg can hardly work an injustice. To me it seems less safe to say that in traumatic hernia the inguinal ring is always small, barely admitting the tip of the index finger. Brandenburg considered any ring which admitted more than the tip of the index finger, or the absence of a true inguinal canal, a predisposition to hernia. . . .

"A recent hernia is tender, and painful on manipulation, and an ecchymosis is not infrequently present. Immediate strangulation is common, and it is said that the majority of cases judged traumatic and granted compensation in Germany are cases in which the hernia was strangulated when it first appeared."

The employer cannot be charged with the payment of compensation in cases where the workman is uncertain as to the manner in which he received the hernia. If he cannot fix the time and the place and the manner definitely and to a certainty in the evidence, he has not suffered such a hernia as will entitle him to compensation.

If the hernia is the result of an actual accident, a traumatic injury, then it is compensable; if it appears gradually under circumstances bewildering even to the claimant, then it is not a compensable injury in that it is not accidental.

In those states where the payment of compensation is not based upon "accidental" injuries, but upon

"personal injuries," as in Massachusetts, then hernia will be compensated under circumstances not so favorably received in other jurisdictions where the line is more sharply drawn.

In a Wisconsin case it was held that a violent straining of the muscles, resulting in a rupture or other bodily hurt from physical overexertion in performing work is included within the term "accident" used in the compensation act. Thus, muscular spasm caused by straining the muscles of the right side while attempting to lift a heavy cement block is an accident within the meaning of the act.

In Iowa it was held that death resulting from a ruptured artery was not accidental when a factory workman stood on a chair and reached out to close a window during a rainstorm and did not slip or fall or lose his balance and nothing unforeseen occurred except the bursting of the artery.

In a New York case, the employee suffered from the result of a cerebral hemorrhage induced by overexertion. The claimant's physician testified that the injury was "rupture of the cerebral artery on the right side, producing a clot of blood on the brain and suffering the complete paralysis of the left side." The claimant was awarded compensation.

Electric Heat Treatment of Ball-Bearing Races

The Electric Furnace Co., of Alliance, Ohio, recently placed in operation an automatic electric heat-treating set for treating ball- and roller-bearing races at the Standard Roller-Bearing plant of Standard Steel & Bearings, Inc., Philadelphia, Pa.

This equipment is composed essentially of a through type of pusher furnace, an oil-quenching tank and an oil-drawing bath, all arranged in series for a continuous flow of material. Both the furnace and oil-drawing tank are electrically heated.

The flow of material through the heat-treating set is regulated by a clock contactor, which is shown, together with its electrical control, at the left of the furnace in Fig. 1. The intervals between contacts may be varied over a considerable range to accommodate different classes of material.

The hardening furnace (Fig. 1) is of the Electric Furnace Co.'s standard carbon resistor type, and is

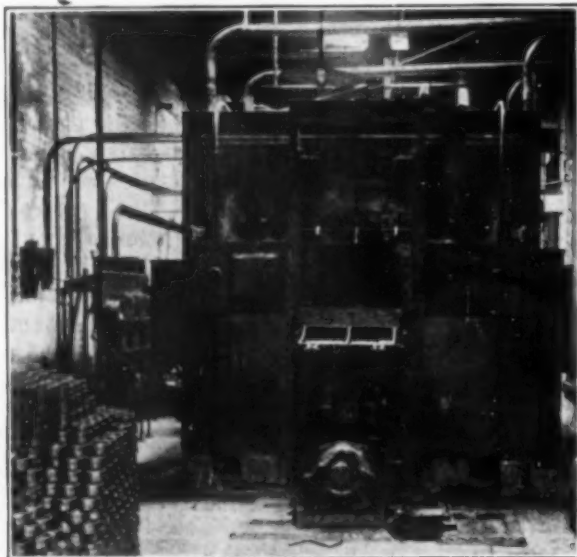


FIG. 1. CHARGING END OF HEAT-TREATING SET

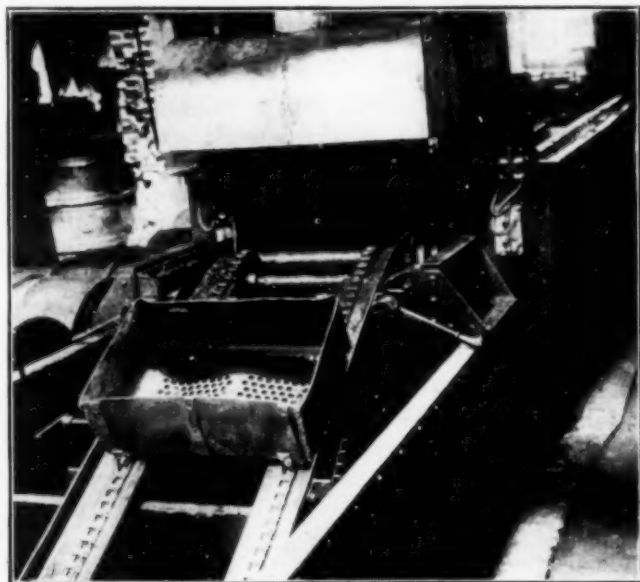


FIG. 2. CONVEYOR LIFTING CONTAINER FOR QUENCHING BATH PREPARATORY TO SLIDING INTO DRAWING TANK

rated at 150 kw. It is equipped with pyrometric control and for average tool steel is maintained at 1,525 deg. F.

The drawing tank has nichrome resistors immersed below the oil surface, and arranged along the sides of the tank, the oil being maintained at a temperature of about 350 deg. F. by means of an automatic temperature controller. About 40 kw. is required for the drawing tank when in operation and handling 1,000 to 1,200 lb. of material per hour.

In operation, rings or other small parts to be hardened are placed in perforated metal trays shown in Fig. 2, holding approximately 125 lb. These trays are then placed on a sill in front of the motor-operated pusher. At intervals corresponding to the setting of the clock contactor, the doors open and the tray is pushed into the furnace. At the same time a tray of material which has reached the correct hardening temperature is pushed out of the far end of the furnace and slides down an incline into oil, where it is quenched.

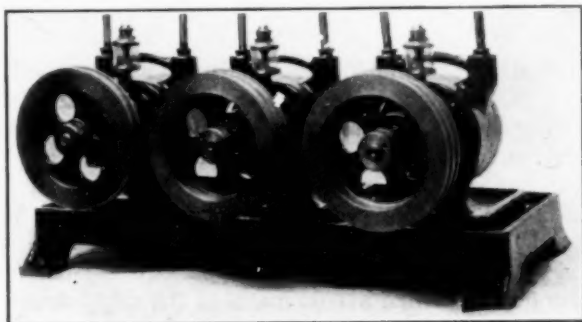
A motor-operated centrifugal pump, started when the door opens, forces a current of oil up through the perforated bottom of the tray almost with sufficient force to float the rings, the object being to chill the rings quickly and to prevent the formation of vapor films or pockets around the heated stock. The length of time the trays remain in the quenching bath is determined by the setting of a small synchronous-motor timing-element by means of which the time can be varied from 1 to 4.5 minutes. At the expiration of this determined time, the tray is removed from the bath by means of a motor-driven inclined sprocket chain shown in Fig. 2, the tray draining of surplus oil until another cycle commences, when a further movement of the chain feeds the tray into the drawing tank. Here, the trays move slowly and continuously forward carried on an independent sprocket chain, which is in turn supported on steel guides. The time required for a tray to pass through the drawing tank can be varied by a gear-set very similar to the speed-changing gears of a lathe.

This arrangement thus gives an exacting control of both time and temperature and is so flexible that it can be quickly changed to fit almost any schedule or conditions required in heat treatment.

New Type of High Vacuum Pump

The Newark Engineering & Tool Co. has recently developed a high vacuum pump. In most all cases, such pumps are immersed in oil to prevent leakage; but in this new design, the engineers have departed from the usual practice of having the pump body immersed in oil. The pump is sealed by means of oil, internally only, thereby saving all the oil used in the outer casing.

Owing to these new mechanical features, from 80 to 90 per cent of the oil can be saved as well as con-



HIGH VACUUM PUMPS FOR AUTOMATIC EXHAUST MACHINES

siderable trouble which is coincident with the use of oil. This pump was especially designed for use in the manufacture of incandescent lamps, and has proved adaptable for X-ray, rectifying, vacuum furnaces and scientific research.

The single pump weighs 50 lb. It has a $7\frac{1}{2}$ -in. pulley for round belt. A speed of between 275 and 300 r.p.m. is recommended with a $\frac{1}{4}$ -hp. motor.

The accompanying illustration shows three pumps mounted on a common pedestal, adaptable for automatic exhaust machines used in the lamp industry.

New Solder for Aluminum

The difficulties encountered in attempting to solder aluminum are familiar to all who have experimented with the multitude of so-called aluminum solders which have appeared within the last few years. One of the chief sources of annoyance has been the tendency for electrolytic corrosion to set in at the joint, the aluminum being corroded, since the components of these solders are electro-negative to aluminum. This difficulty has been successfully met and a new solder, the components of which are located so close to aluminum in the electro-chemical series that electrolytic action is rendered negligible, has been placed on the market by the Rohde Laboratory Supply Co. of New York City.

This material—which is called "Al-Solder"—is applied at a temperature of about 500 to 600 deg. F., so that warping and other mechanical disturbances are avoided. After a moment's heating, an exothermic reaction takes place with the formation of an alloy. Since an alloy is formed with the aluminum, the durability of the joints is permanent and the seams can be made invisible by polishing, which is very desirable in instrument work, etc. Furthermore, the joint may be reheated without injury so that an additional piece may be joined on without any trouble.

Al-solder may also be used in soldering copper. It is a quick and ready oxide remover and flows in any commercial grade of soft solder under the most difficult conditions. It is hygroscopic and consequently must be kept in an airtight container.

Synopsis of Recent Chemical & Metallurgical Literature

Fatigue Strength of Aluminum.—In order that aluminum may maintain its present growth in output, W. A. GIBSON contends that the user should be convinced of the fact that castings and forgings of its alloys may be introduced into places where strength is most desirable, and weight but a secondary consideration. In his paper, "Fatigue and Impact Fatigue Tests of Aluminum Alloys," read before the 1920 meeting of the Society for Testing Materials, he presents the results of a long series of experiments, which show a sharp distinction between the alloys as cast and those as forged, the properties of the former being very sensitive to melting, molding and pouring practice. Testing in a White-Souther machine (rotating cantilever) and plotting stress against cycles on semi-logarithmic paper, the deviation from a straight line is very marked at low loads, bending upward in such a way that extrapolation would be sure to give largely excess safety. Cast aluminum is liable to vary widely as to yield point and proportional limits, yet the maximum stress, hardness, and the fatigue resistance are relatively close, showing that the ultimate depends upon a different combination of properties than the elastic strength. Only one series of cast iron fatigue tests were available, but it is located close to the curves for cast aluminum. Steady pounds are resisted better by ductile materials—thus the Charpy impact test is comparable to ductility measurements. This is not true for alternating non-impact tests, however.

If comparison is made between duralumin and carbon or nickel steel, weight for weight, the aluminum alloys are found to be equal or superior under impact fatigue, a type of stress ordinarily encountered in machine parts.

Nickeling Aluminum and Aluminum Alloys.—Up to the last few years the nickeling of aluminum and of its alloys has been considered impossible of realization with satisfactory results, especially as to good adherence of the nickel coating. LEON GUILLET and MAXIME GASNIER have studied this problem and have presented the results of their work before the French Academy of Sciences (*Comptes Rendus*, May 25, 1920, pp. 1253-1256). Micrographic examinations of nickeled products showed clearly that the adherence of the coating is a function of the efficient penetration of the nickel in the cavities of the product to be nickeled. Very satisfactory results were obtained on sand-blasted parts. The conditions influencing this operation are:

- (a) Rapidity of the sandblast, which is a function of the pressure of the air used and of the airpipe.
- (b) Size of the grains of sand.
- (c) Time elapsed between sandblasting and nickeling.
- (d) Thickness of the layer of nickel.

The conclusions to which they arrived are:

1. Best results are obtained by using sand passing through a 0.2 mm. (0.008 in.) mesh sieve.
2. The most convenient pressure for the sandblast is 1.5 kg. per sq.cm. (21.5 lb. per sq.in.).
3. The nickeling is not affected appreciably by the

length of time elapsing between the sandblasting and nickeling.

4. The best adherence is obtained when the thickness of the coating is not more than 0.01 mm. (0.0004 in.).

They have also worked on nickeling by using an intermediate layer of copper. The entire operation consists of:

Sandblasting with 0.2 mm. (0.008 in.) size sand under a pressure of 1.5 kg. per sq.cm. (21.5 lb. per sq.in.); nickelplating to a thickness of 0.006 mm. (0.00024 in.) which requires 0.5 hr. with a current of 0.8 amp. per sq.dm.; copperplating to a thickness of 0.02 mm. (0.00079 in.) which requires 2 hr. with a current of 1 amp. per sq.dm.; polishing; nickelplating to a thickness of 0.005 mm. (0.0002 in.) which requires 1 hr. with a current of 1 amp. per sq.dm.; polishing.

This last method of nickeling gives excellent mechanical and chemical results. The electrolytic baths used were:

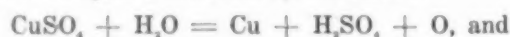
For nickeling: 150 g. nickel sulphate and 50 g. nickel-ammonium sulphate per liter of water.

For coppering: 150 g. copper sulphate and 20 g. sulphuric acid per liter of water.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Electrolytic Process.—In the electrolysis of impure copper solutions such as are obtained in leaching copper ores with sulphuric acid there is usually present ferric sulphate, which has deleterious effects on the efficiency of the operation. The presence of ferrous sulphate is not particularly harmful, however. During electrolysis copper is deposited at the cathode and sulphuric acid and ferric sulphate liberated at the anode:



The ferric sulphate will combine with the copper deposited on the cathode and is reduced to the ferrous condition:

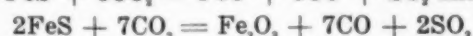
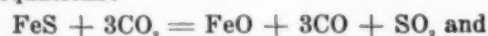


The result of these reactions is a loss in current efficiency; if, however the ferric sulphate can be reduced by a comparatively cheap reducing agent, such as hydrogen sulphide or copper sulphide, sulphuric acid is regenerated and the ferric sulphate will not combine with deposited copper, the efficiency of the process being thereby improved.

Apparatus is described whereby the process can be carried out. (1,340,826; WILLIAM E. GREENAWALT, Denver, Col.; May 18, 1920.)

Production of Carbon Monoxide.—In order to reduce to a minimum the amount of carbonaceous material employed in the recovery of metals from their oxides ANTONIUS FOSS and B. J. HALVORSEN, of Christiania, Norway, treat the carbon dioxide obtained from the reduction of metallic oxides or from other sources with metallic sulphides in a suitable furnace. As an example

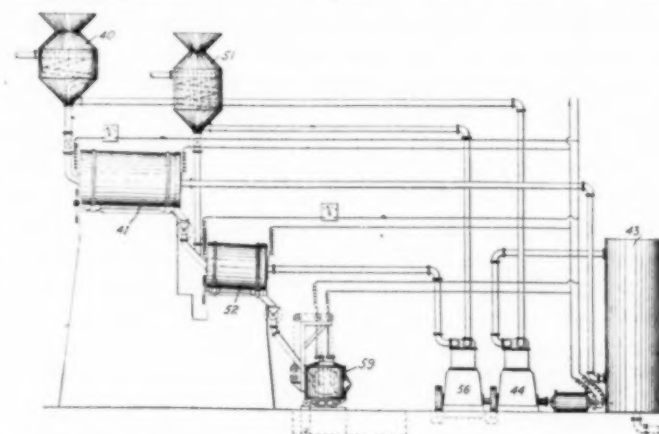
iron sulphide will react with carbon dioxide as indicated in the equations:



The reaction commences at about 600 deg. C., but proceeds better at higher temperature up to about 1,000 deg. C., if the sulphide treated is not fused. The sulphur dioxide is removed by scrubbing towers and may be used in the manufacture of sulphuric acid, sulphite of lime or liquid sulphur dioxide, and thus carries a substantial part of the cost of the process. (1,340,480; May 18, 1920.)

Production of Iron Without a Blast Furnace.—The modern blast furnace is the accepted apparatus for producing iron from its ores, but requires large-scale production, necessitating a large capital investment. It is also inefficient in consumption of fuel and in the utilization of relatively small sizes of ore, fuel and flux. GUYON F. GREENWOOD, of Georgeville, Que., has developed a metallurgical method and apparatus for the production of iron which avoids many of the disadvantages of the blast furnace. The essential features are the reduction of iron oxide by means of carbon with the exclusion of air in an electric resistance furnace and at a temperature and pressure favoring the production of carbon monoxide, the latter being used as fuel in a gas engine and generating electric energy utilized in heating the electric furnace.

The process is preferably carried out as illustrated diagrammatically in the figure. The furnace 41 pro-



APPARATUS FOR THE PRODUCTION OF IRON WITHOUT A BLAST FURNACE

duces coke from coal which is fed into the furnace from hopper 40 and preheated by the heat in the exhaust gases from the gas engine 44. The fuel for the engine is obtained from combustible gases from the coking of the coal after passing through scrubber 43. Ore and flux, together with the coke, are fed into furnace 52, the ore and flux being preheated in hopper 51 by the heat in the exhaust gases from the gas engine 56. The furnace 52 is maintained at a temperature of about 750 deg. C. and at a slight vacuum without the admission of oxygen. The iron oxides are reduced without producing a slag, and carbon monoxide results which is used as fuel for engine 56. The reduced charge is fed into the electric furnace 59, the impurities slagged off and the iron refined. A minimum amount of heat is wasted and sufficient power is developed by the gas engines to furnish the electric energy for the electric furnaces. (1,338,439; April 27, 1920.)

Coolidge Wrought Tungsten Patent Is Declared Valid

THE Coolidge wrought tungsten patent, under litigation for nearly five years, has been declared valid and infringed in a decision handed down early in July by Hugh M. Morris, Judge of the United States District Court, in the suit brought by the General Electric Co. against the Independent Lamp & Wire Co. of New Jersey.

In the court's opinion the following points in the development of ductile tungsten and the process for producing it were considered:

The history of tungsten for upward of a century after its discovery in 1781 is brief. . . . From the beginning of the nineteenth century efforts were made to cast it, reduce it to plates or draw it into wires, but, with certain possible exceptions which will be hereinafter considered, it was with frequency and uniformity pronounced hard, brittle, unworkable and non-ductile. As late as 1903 Sir Robert Hadfield, a leading metallurgist, in a paper read before the British Iron and Steel Institute, said: "As far as we know the metal tungsten, like chromium, is not malleable. If an absolutely pure metal could be obtained, possibly this statement might have to be modified, but the purest forms which the author has been able to obtain possess hardness, brittleness, and are not ductile either in the ordinary or heated condition." . . . Chemists and metallurgists continued to say that tungsten, whether cold or hot, was neither malleable nor ductile; that it could not be drawn into wires. For instance, in "The Petty Metals, Titanium, Tungsten, Molybdenum," by Truchot, published in 1905-6, it is said: "Like chromium, tungsten is not malleable or ductile, whether cold or hot. When pure, it is hard and brittle." In Roscoe & Schorlemmer's Treatise on Chemistry, revised by Sir H. E. Roscoe, F.R.S., and Dr. A. Harden, in 1907 it was stated: "The purest forms of tungsten at present obtainable are hard and brittle, and are not ductile either at ordinary temperatures or when heated." Even as late as 1910, in "Illumination and Photometry," by Prof. Wickenden of the Massachusetts Institute of Technology, this statement occurs: "The metallurgy of tungsten is very complex and the metal when refined is non-ductile." Consequently a problem remained to be solved. It was said: "The elimination of this excessive brittleness is the crux of the tungsten lamp problem."

COOLIDGE REVOLUTIONIZES USES OF TUNGSTEN

The specific problem was how to make ductile a metal naturally and normally non-ductile. To the solution of this problem the lamp manufacturers in Europe and America bent their every energy. Coolidge solved it and produced wrought tungsten or "Coolidge metal" having properties differing most radically from those of the normal or natural tungsten metal. Tungsten is non-ductile, Coolidge metal is remarkably ductile; tungsten is absolutely brittle at ordinary temperatures, Coolidge metal is pliable and flexible; tungsten is fragile and easily broken, Coolidge metal is stronger than steel. The new metal is so ductile it may be drawn into wires uniform in quality miles in length; it is so flexible that it can be tied in a knot or used as a thread to sew on buttons; its tensile strength may run as high as 600,000 lb. per sq.in., while the tensile strength of steel piano wire, the material next in strength, is only about 400,000 lb. to the sq.in.

The announcement of the Coolidge achievement caused much comment. The United States Geological Survey Report for 1910, "Mineral Resources of the United States," published in 1911, says:

No important new uses for tungsten came to the notice of the Survey during the year, but such wonderful improvements were made in the manufacture of tungsten incandescent electric-lamp filaments as to make their use amount almost to a new one. The General Electric Co. so developed the drawing of tungsten into fine wire that, as now made, it is about as strong as steel wire. This has made possible not only the shipping of tungsten lamps with a very small loss from breakage of the filament, but railroad trains and automobiles now carry tungsten incandescent electric lamps. To railroads this means a very great saving in electric power, with a consequent lessening of the weight of storage batteries used or a lengthening of their period of service per charge; or it means that a smaller dynamo will light the train. . . . The toughening of the filament has also made more practicable lamps of large candle power. Tungsten lamps are now used almost everywhere electric lighting is used.

. . . The ductile tungsten filament has gone into general use and has in large measure if not entirely supplanted all other filaments, including that of Just and Hanaman for incandescent electric lamps. It is less expensive to produce, yet it has far greater durability and utility than the squirted filament. It is a commercially new product of great utility having properties and characteristics unknown to the natural and normal tungsten, or, in fact, to any other material. . .

CHARACTERISTICS AND METHOD OF WORKING TUNGSTEN

We may now examine the characteristics of tungsten and the method of working it. A mass of crystalline tungsten, however fine grained, is entirely brittle cold. It may be worked above its annealing temperature, which is exceedingly high, but after being so worked it is still entirely brittle cold. If the mass is worked at a high temperature, but below its annealing temperature, the grains are deformed. This hardens the metal and makes it less workable at the immediate working temperature, but increases its workability at some lower temperature, an entirely new phenomenon. If worked at the lower temperature, the same results follow. At each stage the grains are drawn more and more until a very fibrous structure is produced which is pliable and ductile cold. If the metal is heated to its annealing temperature at any working stage or after the working has been completed, it reverts to its crystalline condition in which it is entirely brittle cold. The most workable condition of other metals is the least workable condition of tungsten and *vice versa*.

It is thus seen that the characteristics of tungsten are peculiar to it and that the method of working tungsten is an exact reversal of the metal-working processes of the prior art, although heat and mechanical forces are used in each. Never with the exception of tungsten have heat and mechanical forces produced ductility in a metal. Furthermore, tungsten is made ductile by working it under its annealing temperature, a method by which brittleness in other metals is uniformly produced.

THE IMPORTANT THING IN THE PATENT

The important thing in this patent, at least so far as the process claims are concerned, is, therefore, a method of procedure, not the particular means by which the method shall be practiced, yet the specifications point out not only the method of procedure but also complete mechanical devices whereby the method can be put into

operation, though the mechanism is not claimed by the patentee. Working tungsten was the ultimate problem, not the preliminary one. It was first necessary to produce the tungsten in a proper condition, next get it into a mass such as an ingot, billet or slug suitable for working, and lastly to work that ingot into the desired filament or wire.

Each problem presented innumerable difficulties. Coolidge's first discovery consisted in finding that a small filament of tungsten prepared in a particular way could be hammered at high temperatures and its form thereby changed. Upon becoming cool the metal so hammered was still brittle. Experiments disclosed that the brittleness was due not to impurities, but was inherent in the nature of the metal itself. Coolidge attempted to draw a filament through wire-drawing dies. He failed. Subsequently, by heating the filament, the die through which the filament was being drawn and the tongs by which it was being drawn, he succeeded. He succeeded in putting the filament through a second die with a draft a fraction of a thousandth of an inch less than that of the first die. The process was continued with die after die. Eventually he discovered that the remarkable thing had been accomplished, yet the filament so ductilized was little more than a laboratory curiosity owing to the smallness of the original mass. The process, though it produced the new product, produced it only in small quantities and at great cost. It seemed inherently inapplicable to ingots of substantial size. Nevertheless Coolidge through years of effort and failure evolved a process by which masses of tungsten substantial in size could be converted into filaments ductile when cold. The method so evolved is the process that revolutionized the electric lamp industry and is the preferred process of the patent. . . .

DEFENDANT ATTEMPTS TO SHOW ANTICIPATION

The solution of the tungsten problem involved invention. The defendant, however, cites certain publications and patents to show anticipation of the Coolidge invention. Among the most important of these is the publication of Moissan, an eminent French scientist, who, in his work "Le Four Electrique," published in 1897, translated by Lenher, when referring to tungsten, said: "When it is porous, like iron, it has the property of being welded by hammering much below its melting point." Moissan placed in a carbon crucible a mixture of tungsten oxide and carbon and heated it by an electric arc. The outer portion of the resulting mass contained carbon absorbed from the crucible and was very hard and brittle. The inner portion of the mass was the porous tungsten of which Moissan speaks. Coolidge tried the Moissan process. He testified: "We were able to take from the center portions which were very porous which could be, by hot working with a hammer, compacted to a certain extent. Upon attempting to really hot-work these pieces—that is, in the sense of elongating them—they cracked all to pieces. It seemed clear to me from Moissan's publication that all he had done was to produce a porous mass of tungsten which could, by hammering, be compacted to a certain extent, and when we, with excellent facilities, tried to go further and make some use of this material, we were unable to do so." . . .

MOISSAN'S CONTRIBUTION A LABORATORY EXPERIMENT

Moissan's contribution was a laboratory experiment that has never proved of any value in practice. Apparently it taught the world nothing. It is inconceivable

that Just and Hanaman could have attained fame by their inferior fragile squirted tungsten filament if those skilled in the metal-working art had learned from Moissan years before how to work tungsten. Dr. Liebmann testified that he performed the Moissan operation and says: "I obtained a product which tallied exactly with the description given by Moissan." But where Moissan stopped, there Dr. Liebmann stopped. I look in vain among defendant's exhibits for a filament drawn from the porous tungsten of Moissan. I am constrained to conclude, therefore, that the Moissan metal cannot in fact be worked and that Moissan did not in truth discover that tungsten is susceptible of being worked. But this conclusion is not supported by inference alone, for enlarged photographs of the Moissan metal hammered by Dr. Liebmann show very little, if any, deformation but do show very large cracks. Manifestly Moissan did not teach Dr. Liebmann how to work tungsten.

COURT REJECTS ANTICIPATION PLEA

Again, it expressly appears from the record that to be workable the tungsten mass must be coherent, not porous. To convert the porous mass into a coherent mass "welding must take place." Yet "under the most ideal conditions commercially available at the present time" tungsten cannot be welded. It would seem that Moissan's hammering closed only a few pores in the spongy mass. We have seen above what Sir Robert Hadfield in 1903 said of tungsten. Moissan failed to teach him to perform the process or make the product covered by the Coolidge patent. Just and Hanaman and Dr. Coolidge, as well as Sir Robert Hadfield and Dr. Liebmann, were uninstructed by the Moissan publication. In fact I do not find that the disclosure of the Moissan publication was sufficient to enable any one to perform the process or make the product covered by the ductile tungsten patent. It necessarily follows that if the Moissan publication did not instruct how to work tungsten in a practical sense it did not disclose that tungsten could be so worked, or that Moissan discovered that it was susceptible of being so worked. "Novelty," says Walker in his work on patents, Sec. 57, "is not negated by any prior patent or printed publication, unless the information contained therein is full enough and precise enough to enable any person skilled in the art to which it relates to perform the process or make the thing covered by the patent sought to be anticipated." . . .

Dr. Liebmann was formerly an employee of the General Electric Co., where he also worked in its laboratory "on the problem of developing the ductile tungsten filament." He left the employ of the plaintiff about August, 1910, when Coolidge's work had been substantially completed, and went to Europe, where he was employed until October, 1912, in connection with the manufacture of carbon lamps and squirted filament tungsten lamps. He returned to America in October, 1912, and "started at once to install modern machinery for the manufacture of tungsten lamps in the factory of the Independent Lamp & Wire Co. (the defendant), and also to proceed with the manufacture of ductile drawn wire for these lamps." Hence it appears that Dr. Liebmann learned how to draw tungsten according to the plaintiff's method. . . .

For the foregoing reasons that main product and process claims are in my opinion valid. . . . All the claims of the patent therefore will be held valid and infringed.

Current Events

in the Chemical and Metallurgical Industries

Minerals Separation-Miami Contempt Proceedings Dismissed

On July 13, Judge Morris in the United States District Court, Wilmington, Del., gave an order dismissing the petition of Minerals Separation which sought to punish the Miami Copper Co. for contempt of court and restrain that company from continuing to operate its processes which, according to affidavits of Minerals Separation experts, are not more than a mere colorable change in the plaintiff's process. In making the order, the court said:

The plaintiff now charges by petition that the processes employed by the defendant since it stopped using the three processes heretofore adjudged to be infringements are also infringements and prays that the defendant be adjudged guilty of contempt and/or that a further injunction be issued specifically enjoining and restraining the defendant from using such processes.

The defendant by its answer denies that the new methods infringe the patents sued upon and moves that the rule to show cause be vacated and the petition dismissed upon the ground that, due to the character of the new processes, the present procedure is inappropriate for the determination of the questions raised. The plaintiff contends that it appears from the facts alleged that the new methods are the same in principle as those adjudged to infringe and that the defendant has made only a substitution of equivalents resulting in a mere colorable change in the process, while the defendant contends that those facts disclose that it no longer uses the agitation of the patent. Much testimony touching the processes in question has been introduced by the plaintiff before the master upon the accounting now being had. In fact, it is conceded that little testimony of any other nature has so far been presented.

The present issues do not seem to make necessary a review of the cases upon contempt or those in which the procedure by supplementary injunction has been recognized. Although embarrassed by the fact that I do not possess the full knowledge of the intricate facts of this case that might have been gained had the testimony and argument in the main cause been heard by the court as now constituted, I am, nevertheless, satisfied that the facts set up by the petition are not of the character required to sustain a judgment of contempt. Nor do I find that the practice of enlarging an injunction or granting a supplementary injunction has been adopted in this circuit. But, be that as it may, in view of the nature of the new processes used by the defendant as charged by the petition, the questions raised thereby, and the decision of the Circuit Court of Appeals in this case, 244 Fed., 752, I am of the opinion that the plaintiff must obtain the relief to which it is entitled, if any, touching the new processes, either through the proceedings now being had before the master and the decree to be entered thereon, or by a new bill and not otherwise.

On the same day the court gave the following order relative to making Minerals Separation North American Corporation a party plaintiff in addition to Minerals Separation, Ltd.

I have considered the application of plaintiff for leave to file a supplemental bill, submitted with the motion, setting up the filing of a disclaimer as to claims 9, 10 and 11 of patent No. 835,120, and making Minerals Separation North American Corporation an additional party plaintiff, together with the several objections made by the defendant to the filing of the proposed bill, and am of the opinion that it would be in furtherance

of justice to grant the leave to file but without prejudice to the defendant to renew its objections, in a manner then suitable, to the bill when filed, if it be so advised. An order so providing may be submitted.

Progress in the Federated American Engineering Societies

The Technical Club of Dallas, at its meeting June 2, made application for membership in the American Federated Engineering Societies, being the first local organization to apply. At its recent annual meeting held in Montreal, June 28, the American Institute of Chemical Engineers discussed favorably the question of becoming a member of the F.A.E.S. and referred the matter to the Council for definite action at its meeting on July 25. The opinion was expressed, however, that the Institute should be a member of the new organization, even if an assessment was necessary to meet the financial obligation. The board of directors of the American Institute of Electrical Engineers adopted a resolution at its meeting at White Sulphur Springs, W. Va., June 30, approving membership of the Institute in the F.A.E.S., but deferring action on account of the fact that a new board will be instituted Aug. 1. The board of directors of the American Institute of Mining and Metallurgical Engineers discussed the matter favorably on June 25, and referred it to the finance committee to devise means of meeting the financial requirements. The Civil Engineers are expected to consider the report of their delegates to the Washington Conference at the annual convention of their society at Portland, Ore., Aug. 10 to 12.

Eastman Kodak Co. Purchases Plant at Kingsport, Tenn.

The American Wood Reduction Plant at Kingsport, Tenn., has recently been purchased by the Eastman Kodak Co. This plant, located on a 35-acre site, was built during the war and taken over by the Federal Government for the manufacture of wood alcohol. Original cost of the plant is said to have been \$1,100,000.

As the Eastman Kodak Co. is one of the largest users of wood alcohol and has had to depend on the outside market, it has decided to manufacture its own supply. Engineers and officials of the company are said to be now considering the advisability of enlarging the plant to manufacture other chemicals used in photography. The price paid for this property by the Eastman interest is not stated, but it is understood to be about \$1,000,000.

The immense potential possibilities of the South as a source of power, raw materials and plant sites have only recently begun to be appreciated. As an instance of the effect of establishing a large industry in the South it might be stated that the town of Kingsport, which in 1910 had a total population of 200, now boasts of over 10,000 inhabitants. If more industries could be interested in the possibilities of the South, a great deal could be done to develop its natural resources.

Federal Trade Commission Hearings at San Francisco in Minerals Separation Case

Hearings for the purpose of obtaining further testimony in this case were conducted in San Francisco July 6 to 10, 1920. These were a continuation of the hearings begun in New York on April 7 and were to be continued in Salt Lake City, Utah, July 13 to 17, and in Denver, Col., July 19 to 24. The charges against Minerals Separation and other respondents are the suppression of competition by oppressive license agreements and falsely claiming exclusive rights in excess of actual rights in respect to apparatus and processes used in the separation and concentration of ore. They are also charged with discriminating between different users of their apparatus and processes.

E. H. Nutter, chief engineer, and Messrs. Quigley and Roberts, of the San Francisco engineering office of the Minerals Separation North American Corporation, were interrogated regarding the methods used in obtaining lists of companies which were probable or possible infringers of the M. S. process, together with the uses made of these lists and the attitude and action of the field representatives toward infringers. The testimony brought out the fact that no methods which could be considered as threatening or oppressive were in use by the employees or had been in use during the period covered by the indictment. Instruction had been explicit to field representatives to state their connection with Minerals Separation and the object of the intended visit to the plant of a probable infringer, also that the field men should get permission from the official in charge of the plant to inspect the flotation operations.

Other witnesses expressed their opinion as to the terms of the license and the amount of royalty charged licensees. These were declared to be oppressive and excessive. But counsel for respondent brought out the fact that a profit could not be made from the material treated by any other process known to the witness.

MR. HOOVER'S TESTIMONY

The most interesting testimony was that of Theodore J. Hoover, now head of the department of mining and metallurgy of Stanford University. Mr. Hoover was general manager of the Minerals Separation London company from September, 1906, until the end of 1910, or during the period in which the flotation process of the company was being developed. At the time of leaving the employ of Minerals Separation Mr. Hoover took with him files containing information for his guidance in the capacity of consulting engineer to the company. This office he did not fill, and as a result of *ex parte* proceedings all documents and papers taken by Mr. Hoover were examined by officials of Minerals Separation Company and an agreement reached upon those to be returned.

According to Mr. Hoover's testimony he entered the employ of Minerals Separation under a contract which stipulated that during or after his employment he could not impart to any third party any information regarding the flotation process. These terms were considered at the time to be oppressive in that they restricted his possible future activities. This clause in the contract was also the subject of discussions between Mr. Hoover and Mr. Ballot, president of Minerals Separation, during the term of Mr. Hoover's employment with the company. These terms were never receded from by contract but are evidenced in certain letters to Mr. Ballot written by Mr. Hoover in which he expressed what he considered

to be fair terms. The Minerals Separation Company has not modified or released Mr. Hoover from the terms of the contract since he left its employ.

Among the exhibits requested in evidence from Mr. Hoover was a manuscript written by H. S. Sulman and H. K. Picard, consulting engineers and two of the inventors of the Minerals Separation flotation process, on the theory of flotation. This manuscript was among the papers which were inspected by the Minerals Separation officials, but was not discussed in particular at the time of the legal proceedings nor was its return mentioned subsequent thereto.

CONSIDERS COMPANY'S CLAIMS EXCESSIVE AND FRAUDULENT

In August, 1919, Mr. Hoover entered the employ of the Miami Copper Co. as consulting engineer. As a result of the knowledge gained through investigation of the evidence afforded in the Miami case, Mr. Hoover became convinced that the claims made by Minerals Separation for its process were so far in excess of the claims made by certain of the inventors of the process as set forth in their treatise as to "constitute an attempt to perpetrate a fraud upon the court." Mr. Hoover resigned his position with the Miami Copper Co., and after consulting legal opinion and obtaining advice from brother engineers, Mr. Hoover considered it to be his public duty to offer the manuscript in evidence. This manuscript was the same one that was submitted in evidence in the flotation litigation between Minerals Separation and the Miami Copper Co., upon which we commented editorially in our June 30 issue.

T. A. Rickard, editor of the *Mining and Scientific Press*, testified that the effect upon the mining industry which resulted from the company's policy of preventing the publication of information regarding the flotation process was to retard development both of the industry as a whole and the process in particular.

Shortage of Anhydrous Ammonia

A serious shortage of anhydrous ammonia, which may occasion great losses of foodstuffs which must be placed in cold storage during the summer, is reported by the Bureau of Markets of the Department of Agriculture. There is no shortage of raw materials. The scarcity of the finished product is attributed to a number of reasons.

During the war large quantities of ammonia were sent to France in drums. The priorities which have existed on ocean freights have precluded the return of these drums. For a long time manufacturers withheld orders for new drums, expecting from week to week that arrangements would be made for the return of the drums in France. Finally when nothing definite could be learned as to when the drums could be returned, orders were placed for new drums. This was about the time of the steel strike and a long delay resulted before delivery could be made. The drums had no more than begun to arrive when the coal strike cut down the output of byproducts from the coke ovens. The next difficulty to arise was the switchmen's strike which has retarded deliveries so as to round out an unusual combination of difficulties which accounts for the fact that there are no reserve stocks of ammonia.

The Bureau of Markets is taking steps to acquaint all users of ammonia with the situation and will urge them to do all possible to prevent waste and to make efficient use of the supplies which they have on hand.

Convention of the American Electroplaters' Society

The large attendance at the convention of the American Electroplaters' Society, held in Rochester, N. Y., July 1 to 3, 1920, and the willingness of the platers and chemists present to discuss their problems and to impart information, augur well for the future of the American Electroplaters' Society, of which this is only the eighth annual convention. The noticeable dearth of technical papers may be accounted for in part by the unsettled business and labor conditions which have no doubt prevented many platers from trying out new or improved methods or of perfecting them to the point for publication. In future conventions such papers probably will be more numerous; in fact they must be, if the society is to progress. To this end the manufacturer should encourage and assist his plater to develop and apply new methods and thus avoid stagnation. In those plants where both chemists and platers are employed, they should work together in a spirit of co-operation, to improve processes and to secure more exact knowledge of existing methods. If for example in each of twenty-five such plants, definite data upon some phase of plating were secured each year, there would be no dearth of papers for future conventions, and a mass of reliable information would soon be accumulated.

USE OF HYDROFLUORIC ACID IN NICKEL-PLATING SOLUTIONS

The subject which received most consideration in the technical sessions was the use of hydrofluoric acid in nickel-plating solutions. This substance has been used so successfully by E. G. Lovering of Detroit that he has christened it the "magic fluid." A preliminary report from the Bureau of Standards described the results of experiments upon the application of hydrofluoric acid in nickel baths used for the electrolytic production of printing plates in the new plant of the Bureau of Engraving and Printing.

This paper was discussed at length by Messrs. Lovering, Allen, Woodmansee, Herrick, Madsen, Hogaboom, Slattery and others. From the paper and its discussion it seems to be clearly established that nickel can be deposited from solutions containing hydrofluoric acid (or ultimately nickel fluoride or fluoborate) more rapidly than from the ordinary solutions. These deposits are brighter and have a finer structure and higher tensile strength, and are harder but less ductile than deposits produced in the customary baths. The fluoride deposits are therefore more difficult to buff, but for the same reason they show greater resistance to abrasion. Such deposits are likely to be especially valuable in electroplating, or for the nickel plating of objects subject to abrasion in service. The whole subject is greatly in need of more exhaustive investigation, and the chief value of this discussion was to emphasize the great possibilities involved in the study of even such well-known baths as are used in nickel plating.

OTHER PAPERS—PLANTS VISITED

Other papers discussed in the meetings were:

"Anode Hooks," by H. F. Sperry.

"Nickel Plating on Zinc and Die Castings."

"Sanitation in Plating Rooms," by G. Wilson.

"Ball Burnishings," by R. Hazucha.

"Oxidizing (i.e., coloring) Aluminum," by F. J. Hanlen.

Among the plating plants visited were those of the

Eastman Kodak Co., the Taylor Instrument Co., the Bausch & Lomb Optical Co., the Northeast Electric Co., the Van Bergh Silver Plating Co. and the General Railway Signal Co. These manufacturers are to be congratulated upon their broad-mindedness in permitting such inspection, thus advancing the educational aims of the Electroplaters' Society.

BROADENING OF MEMBERSHIP DISCUSSED

The most important business before the convention was the question of admitting assistant foreman platers to associate membership in the society. At present active membership is restricted to actual foreman platers; associate membership is restricted to persons who were formerly foreman platers but are now salesmen for plating supply houses, and to chemists or metallurgists interested in electroplating. After lengthy discussion, the amendment to admit assistant foremen as associate members was referred to a referendum vote of the society. The decision upon this question will be of great importance, not alone to the electroplaters, but also to the chemists and manufacturers, since the future progress of the whole electroplating industry depends upon an intelligent and sympathetic education of those younger men, who will in time become the actual foremen and superintendents.

CO-OPERATION IN STANDARDIZATION AGREED UPON

The society accepted an invitation from the Metal Finishers Equipment Association to co-operate with it in the standardization of materials and supplies used in electroplating. Clear definitions of terms and materials in some cases (with tentative specifications of purity or quality) will be valuable alike to the electroplaters and their employers, and will enable purchasing agents to secure on the open market supplies of adequate and uniform quality, and will permit chemists connected with plating plants to conduct more intelligent control work than when supplies are purchased with no definitions or specifications. The committee on research and standardization, to which this matter was referred, can render great service through such co-operation.

AID FOR RESEARCH WORK

To the same committee was referred the matter of securing, for manufacturers interested in plating, financial support for research work, to augment the limited funds now available for such work at the Bureau of Standards. In this discussion it was emphasized that such support should be viewed by each manufacturer, not as a contribution, but as an investment, certain to yield results of value to him as well as to the whole plating industry.

SOCIAL FEATURES

The entertainment and social features of the convention were very successful and enjoyable. In thus supplementing the business and technical sessions by social gatherings, the delegates and guests not only were entertained, but were also afforded that opportunity for acquaintance and for intimate discussion of their daily problems which is after all one of the chief advantages of a convention, especially for a society which is still almost in its infancy, but showing a healthy growth. Ten years ago such a gathering would have been unheard of in the plating industry. With the spirit shown at this meeting, there is no question of the still greater growth and development in the next decade.

Fertilizer Manufacturers Seek Government Aid to Relieve Car Shortage

Strong representations have been made to the Interstate Commerce Commission and to the committee on car service of the American Railway Association in an effort to secure more cars for the fertilizer industry. Between now and the middle of September, 40,000 carloads of mixed fertilizer should be distributed. In addition 25,000 carloads of fertilizer raw materials must be moved in the near future. It was pointed out that fertilizers were given the benefit of priorities during the war, and that the need for their use is greater now than then.

As a result of persistent efforts farmers have been induced to place their fertilizer orders early this year. This was done with the idea of lowering the peaks in the distribution of fertilizer. The plan worked out more successfully than had been anticipated, but the distribution cannot be carried on in the required volume, as cars cannot be obtained in sufficient number to take care of the transportation.

Due to inability to secure phosphate rock many acid plants have been forced to close, the committee on car service was told. Practically every plant in the country is receiving its supplies in a hand-to-mouth manner. Not less than 250 cars daily are required to handle the necessary phosphate rock from Florida. About 50 per cent of the cars needed are being furnished at present. The same is true of the car supply on the Louisville & Nashville, over which most of the Tennessee phosphate rock reaches fertilizer plants.

The committee which came to Washington to take up the matter of car supply was composed of Spencer L. Carter, Virginia-Carolina Chemical Co.; DeWitt Brown, Armour Fertilizer Works; Robert B. Allen, Smith Agricultural Chemical Co.; T. A. Bosley, Virginia-Carolina Chemical Co.; A. S. Key, Federal Chemical Co.; H. Braunlich, American Agricultural Chemical Co.; J. W. Hoyt, International Agricultural Corp.; D. A. Dashiell, F. S. Royster Guano Co.; Douglass Ober, G. Ober & Sons; A. D. Whitmore, American Cyanamid Co.; Frank G. Moore, Davison Chemical Co.; J. W. White, International Agricultural Corp.

The committee was accompanied by representatives of the Bureau of Soils.

Industrial Research Laboratories in America

A bulletin just issued by the National Research Council lists more than 300 laboratories maintained by industrial concerns in America, in which fundamental scientific research is carried on. The bulletin gives a brief account of the personnel, special equipment and particular kind of research carried on in each of the laboratories listed.

Industrial research laboratories have increased notably in number and activity, both in America and Great Britain, since the beginning of the war, because of the lesson vividly taught by the war emergency. It was only by a swift development of scientific processes that the Allies and America were able to put themselves in a position first to withstand and then to win a victory over Germany's science-backed armies and submarines. And it is only by a similar and further development that America and the Allies can win over Germany in the economic war-after-the-war, now being silently but vigorously waged.

Cellulose Section, A. C. S., Considered

Under the able guidance of Jasper E. Crane, a Cellulose Symposium was organized as a part of the program of the Division of the American Chemical Society last April. One of the objects of this symposium was to ascertain whether a Cellulose Section, if formed, would secure the interest and support of a sufficiently large number of chemists. The object of such a section would be to promote intercourse and co-operation among the chemists in the various cellulose industries. This group constitutes one of the largest and most important of American industries; all branches of it are intimately concerned in the problems of cellulose, and it seems highly desirable to promote technical activity in this country along these lines. The proposed section would serve as a clearing house for papers and information on cellulose technology, and should also play an important part in promoting research on the chemistry of cellulose.

The symposium at St. Louis was distinctly successful. The interest shown was so great that it was voted to hold a second Cellulose Symposium under the auspices of the Industrial Section at the Chicago meeting during the week of Sept. 6. At this time the advisability of forming a permanent Cellulose Section will be considered. An interesting program is being arranged, and a large attendance of those interested in cellulose is anticipated.

Titles of papers or suggestions for the symposium should be sent to G. J. Esselen, Jr., 30 Charles River Road, Cambridge, 39, Mass.

Foundrymen's Exhibit Grows

The growing appreciation of the important work that the American Foundrymen's Association is doing manifests itself in the increased demand for exhibition space at the Convention and Exhibit to be held at Columbus, Ohio, Oct. 4 to 8. Already 51,000 sq.ft. of exhibition space has been contracted for, with 85 per cent of last year's exhibitors to be heard from.

A number of new exhibitors will be on hand this year, especially in the general shop equipment and machine tool lines, as there is a growing appreciation of the extraordinary purchasing power represented in the A. F. A. attendance, aside from strictly foundry requirements. This is due to the fact that many of the men interested in the foundry meetings also operate machine shops.

A striking feature of these annual shows is the large percentage of operating exhibits demonstrating the equipment by duplicating actual working conditions. Last year more than 50 per cent of the 208 exhibitors used power, 170 motors being in operation and 31 exhibitors using compressed air for demonstrating purposes.

Golden Mine Experiment Station Moves to Reno, Nev.

The Secretary of the Interior has approved the transfer of the Golden Mine Experiment Station to Reno, Nev. The station in the future will be known as the Rare and Precious Metal Station and will be conducted in co-operation with the University of Nevada, which will construct a building especially designed for the use of the station. The building is to cost at least \$30,000. Dr. S. C. Lind will continue in charge of the station at its new location.

Personal

F. T. AGTHE has resigned as plant engineer of the Missouri mills of the Atlas Portland Cement Co., Hannibal, Mo., to join the staff of the Hardinge Co. at York, Pa.

Dr. SCOTT E. W. BEDFORD of the University of Chicago spoke before the Chicago Chemists' Club recently on the organization of the Army educational system.

Dr. W. D. COLLINS, formerly in charge of the analytical reagents laboratory of the Bureau of Chemistry, is now in charge of the U. S. Geological Survey, Quality of Water Division, succeeding R. B. Dole. Dr. Collins will continue as chairman of the American Chemical Society committee on standardized reagents and apparatus.

Dr. F. G. COTTRELL, director of the Bureau of Mines, has been designated to succeed Van H. Manning as a member of the interdepartmental defense board of the Council of National Defense.

Dr. P. M. GIESY, formerly of the dyestuff research department, Grasselli Chemical Co., is now in charge of the betanaphthol control laboratory of the Calco Chemical Co., Bound Brook, N. J.

ELMER ALLEN HOLBROOK has assumed the position of assistant director of the Bureau of Mines, succeeding Dr. Cottrell, who is now director of the bureau. Mr. Holbrook entered the bureau in 1917 as supervising mining engineer at the Urbana station, during the first half of 1919 was made acting chief engineer and in July, 1919, was made superintendent of the Pittsburgh Experiment Station, where he was until called to Washington, July 1, 1920.

Dr. LYNN HAROLD HOUGH has resigned from the presidency of Northwestern University, Evanston, Ill., on account of ill health.

M. O. LEIGHTON and Major C. T. CHENERY, members of the American Society of Civil Engineers, and A. C. OLIPHANT, associate member of the American Society of Mechanical Engineers and the American Institute of Electric Engineers, have formed a copartnership under the name of M. O. Leighton & Co., with offices at 700 Tenth St., Washington, D. C., for the purpose of engaging in general engineering practice and industrial representation before the Federal departments. Mr. Leighton and Major Chenery will continue for the time being as chairman and secretary of the National Public Works Department Association, while Mr. Leighton and Mr. Oliphant will continue service in the Washington office of Engineering Council pending the displacement of that body by the Federated American Engineering Societies.

H. C. MILLER, formerly superintendent of the Round Valley Tungsten Co. of California, is now petroleum production engineer with the Standard Oil Co. at Taft, Cal.

CLIVE SEYMOUR NEWCOMB, metallurgical engineer, has resigned his position with the Dorr Co. to become consulting engineer with the Mutual Chemical Co. of America and the Phosphate Mining Co. His address is 55 John St., New York City.

G. ARNCLIFFE PERCIVAL, chief chemist, The Edison Swan Electric Co., Ltd., Ponders End, Middlesex, England, has returned to England after spending several weeks visiting chemical industries of the Eastern United States.

J. LEONARD REFLOGLE, president of the Replogle Steel Co., sailed for England on July 1.

GUY C. RIDDELL, consulting metallurgist, formerly in charge of metallurgical and mining problems for the U. S. Tariff Commission, is now secretary and consulting engineer of the Wah Chang Trading Corp., 233 Broadway, New York City.

G. C. SPENCER has succeeded W. D. Collins, in charge of the analytical reagents laboratory of the Bureau of Chemistry, Washington, D. C.

Bureau of Mines Strengthens Its Chemistry Department

The chemical side of the investigations being conducted at a number of the Bureau of Mines experiment stations is to be greatly strengthened. The personnel at the stations has been arranged so as to make this possible, with O. C. Ralston at Seattle, L. H. Duschak at Berkeley, C. M. Bouton at Salt Lake City, Dr. Thomas B. Hine at Tucson and Dr. S. C. Lind at Reno.

Current Market Reports

The Iron and Steel Market

Pittsburgh, July 16, 1920.

Shipping conditions at the blast furnaces and steel mills have been still poorer in the past week, due to car shortage, the increase in which is generally attributed to the operation of order No. 7 of the Interstate Commerce Commission according to priority to the coal mines. A large steel interest reports its shipment during the first twelve days of this month less than in the same period of June by an amount equal to about 20 per cent of its productive capacity, but such an experience is probably unusual. A rough guess would be that shipments are at about two-thirds of production, assuming that all the steel made is carried through to finished form according to customers' specifications, the fact being that the amount of steel held in unfinished or semi-finished form is increasing.

The iron and steel interests have objected to order No. 7, not so much to the essence of the order as to the terms by which it has been interpreted, as the average railroad has interpreted the term "coal car" in the present circumstances to include all flat-bottom gondolas measuring more than 30 in. high inside. Partly no doubt on account of the representations of the iron and steel industry, the Interstate Commerce Commission, while extending the order for another thirty days, from July 21, modifies the terms whereby coal cars shall include only those gondolas that are 36 in. or more inside measurement. The industry is of opinion that the difference means a very considerable number of cars, and a corresponding increase in car supplies is to be expected.

Among the representations before the commission there was a statement that in four districts, not including the East or the Chicago district, there was an accumulation of steel awaiting shipment amounting to 1,416,727 tons. Including the districts not taken into the reckoning, and allowing also for steel accumulated, for convenience, in unfinished or semi-finished form, the total of the steel accumulations seems likely to be in the neighborhood of 2,500,000 tons. In this report of a fortnight ago estimates were mentioned ranging from 2,000,000 to 3,000,000 tons.

FINISHING DEPARTMENTS CLOSED

The tendency is stronger to close finishing departments and accumulate steel in ingot or semi-finished form. There is little if any voluntary curtailment of steel ingot or of pig-iron production. At one large plant approximately half the finishing mills are closed at a time, but work is alternated, week about, so as to give all the men some employment. At another large plant there is the exceptional case of practically all finishing departments being closed since the first of the month, to resume next week, while the production of pig iron and steel has continued.

In the case of finished steel there is the double difficulty that storage facilities are already taxed, and that steel made to customers' specifications may prove quite unacceptable at the late date at which the steel will be shipped. When that time will be no one ventures to predict, since shipments are still below production and the beginning has not yet been made in clearing off the accumulations.

The Steel Corporation's increase of 38,351 tons in unfilled obligations in June is small compared with the average

of 550,000 tons a month increase of twelve months preceding, but on the other hand it is remarkable that there should have been any increase when the steel market was so dull. The independents as a whole did not boom nearly as much as they produced, nor even as much as they shipped. Month by month the disparity in order books between the Steel Corporation and the independents has increased, on account of the divergence in prices quoted. In actual orders the independents probably do not have on books a tonnage equal to more than two or three months additional of production, though they have made various arrangements with customers to supply them for later periods on the basis of "price ruling at date of shipment." The Steel Corporation, on the other hand, had 10,978,817 tons of unfilled obligations July 1, this of course including something like three-quarters of a million tons of steel produced but not shipped and therefore not invoiced. The corporation's output at 90 per cent of capacity up to April 1, 1921, would be about this same tonnage.

STEEL PRICES PRACTICALLY STATIONARY

The stocks of steel made to customers' specifications but not shipped are perhaps the best preventive possible of price cutting. At any rate, the large independents show no disposition to reduce prices. On bars, shapes and plates their prices are, respectively, 3c., 3.10c. and 3.25@3.50c., as they have been for months past. There has been the still higher market, made by smaller mills for prompt shipment, and this market continues to trend downward. In plates there is approximately a parity between prompt shipment and any shipment the independents can make. The Steel Corporation's prices for the three products remain at 2.35c., 2.45c. and 2.65c., respectively.

PIG IRON ADVANCING

With pig iron accumulating at the furnaces on account of lack of shipping facilities, with deliveries very scant and prices for early deliveries advancing, the pig-iron market appears to be riding for a fall, but it is a market that has furnished surprises before. Both bessemer and basic have sold in the past week at \$46, valley basis, an advance of \$1 a ton over the previously quoted market. Foundry iron remains nominally at \$45, valley, but may easily show an advance if any prompt demand of consequence develops.

While pig iron is high relative to steel and shows a greater spread over its pre-war average than do commodities in general, the price must be considered low when Connellsville furnace coke is bringing \$18 per net ton at ovens for spot or prompt shipment. Why furnaces are willing to pay such a price, even on the very limited tonnages they buy, is not explained, and every week it is reported that the furnaces will no longer patronize the market.

Shipments of Lake Superior iron ore down the lakes in June amounted to 9,233,566 tons, a fair showing for the month, but on account of the backset in April and May the season total to July 1 is only 16,440,505 tons, against 16,008,419 tons in the same period in 1919, whereas a large increase is desired on account of the heavier operation of blast furnaces this year. There is, however, no danger of an actual shortage of ore, and once more the expressed fear of a shortage is seen to be groundless.

The Chemical and Allied Industrial Markets

New York, July 16, 1920.

The break and sudden decline in prices, frequently predicted to occur in other markets, has hit the crude rubber trade and stopped all business. A member of the trade recently returned from Akron on a tour of inspection in company with a man representing English interests reports that matters are in the worst possible condition and that after having seen numerous tire manufacturers he is convinced that there will be no activity until late fall and possibly not until next year.

The present situation is directly traceable to several causes, viz., the enormous quantities of war surplus material in the Indian market brought about a reversal of form, to the extent that the spot market was quoted below future

delivery. This being an unhealthy condition, buying interests realized that a drop was bound to come and held off waiting for a decline. Tire manufacturers by the vast expansion and additions to their plants had given promise of increasing their output about 10,000 tires a day each, which would necessitate a considerably larger amount of rubber. These plans, however, were abandoned when automobile manufacturers cancelled their rubber contracts because of inability to deliver automobiles by freight.

These conditions are verified by a report of the failure of one of the largest and oldest firms engaged in the crude rubber trade. This concern has on its books *Para*, upriver, bought at 55c., and some idea of the amount of money involved can be gained by comparing that price with current quotation of 35c., which it is not beyond reason would be shaded to 32c. on a large order.

GENERAL CHEMICALS

There has been no change in the position of the chemical market during the current week, buying interests still holding off for lower prices. Despite the lax demand, supplies have not appreciably increased and although there have been some drops, noticeably on *acetic acid*, glacial, which is being generally quoted at \$14.50@15.50 per cwt., a quotation on a 5-ton lot as low as \$13.50 per cwt. has been heard. The market has preserved a tone of firmness in the main. Some other items that have changed during the period are *tannic*, tech., now listed at 60@70c. per lb. on car lots, and *ammonium carbonate*, powder, which has come up from 17½c. to 18c. per lb. The demand for *copperas* that has been so strenuous lately seems to have fallen off slightly and as a result stocks are somewhat improved, but sales ranging as high as \$3.50 per cwt. are still being placed. Both *sodium* and *potassium chlorate* have been advanced by producers and the new levels are 11@12c. per lb. for the former and 15@17c. for the latter, while *sodium bichromate* changed in the other direction, with the low mark at 24c., against 26½c. of the previous week. The pressure of increased demand has forced *calcium chloride*, fused lump, up slightly, and it is now difficult to obtain this material at less than \$25 per ton, while the average price seems to be about \$30; in sympathy with this the *granulated* grade also rose, with 3@3½c. per lb. the prevailing quotation at present. Spot supplies of *aluminum sulphate* are giving way under the heavy buying pressure, with 5½c. per lb. for commercial and 6½c. for iron-free grade being asked for material in second hands. Producers are behind in their contracts and are consequently unable to take any new business.

COAL-TAR PRODUCTS

The recent 5c. flat rise on crude bases put into effect by producers seems to have had the effect of strengthening the market. The improvement in the money situation has also helped in this matter, and although there has been no general increase, nevertheless the downward tendency noticed on several items for the past two weeks has stopped. *Naphtha*, flake, is still unobtainable at a reasonable figure, but for those who must have this material it can be obtained on the spot market at 20c. per lb. One large producer is still delivering on contracts written at 9c., and upon arrival it immediately goes into second hands, probably changing three or four times before reaching ultimate consumer. *Alpha naphthylamine* is somewhat easier and it is possible to locate material at 53c. and lower, while *aniline oil* and *salts* are firmer, although there has been no change in price.

NAVAL STORES

The present volume of business, which vastly improved over the last month, would be still greater if the matter of delivery from the South could be adjusted. The low scale of prices on *rosins* prevailing at present is due to the arrival in the primary market of the new crop, which for the present has relieved the pressure in this market. As can be seen from the table, there is slight increase over last week's prices and the listed prices are those which are expected to be in effect for some time. *Turpentine* came up slightly during the week and is now quoted at \$1.58 per gal., against \$1.49 of the previous period.

The Baltimore Market

Baltimore, July 14, 1920.

There is still considerable doubt in the minds of fertilizer manufacturers as to whether they will be able to secure sufficient labor and cars to fill their orders, and the situation during the next few months will be a question of production rather than of selling. This applies particularly to acid phosphate, and the dry mixers who have not yet covered for their wants will doubtless experience difficulty in inducing producers to take on further commitments for car shipments.

Acid Phosphate. The market remains very strong, and the various producers are still more closely sold up than they have been for some time past. It is next to impossible to place orders for car shipments for any important tonnage, and on account of the labor situation none of the producers is disposed to take on business for shipment in buyers' bags either for July, August or September, as it is doubtful whether they will be able to secure either sufficient cars or labor to fill orders from their regular customers. The nominal quotation for 16 per cent grade in bulk remains at \$20 per ton f.o.b. cars, with run of pile testing 17 to 18 per cent being quoted for water shipment at \$19 per ton, basis 16 per cent A.P.A. However, there is very little buying interest manifested by such buyers as are in position to take delivery by water. The market seems stationary at present level, and producers are more concerned in securing crude materials and filling orders now on their books than in market fluctuations.

Tankage. While the Chicago market remains firm at prevailing levels of \$7.75 and 10c. f.o.b. Chicago, with apparently no anxious sellers, there has been a slight easing up in the nearby Eastern markets, where producers are not in position to carry large stocks, and some sales have been made during the past week as low as \$8 per unit of ammonia and 10c. per unit of B.P.L., basis c.a.f. Baltimore, which is considered somewhat below the general market, and any important inquiries would doubtless have the effect of driving prices up to \$8.15@8.25 and 10c. Baltimore.

Nitrate of Soda. While little buying interest is being manifested, the market remains firm, with prices for summer and fall deliveries ranging from \$3.85 to \$4, depending upon tonnage and deliveries, and January-April shipments nominally quoted at \$4.10@4.15. In view of the fact that the production of sulphate of ammonia, on account of the coal situation, is not up to expectations, some of the manufacturers are inclined to show interest in nitrate.

Potash. Up to the present time the new schedule on the Alsatian product for delivery over the balance of this year has not been announced, and in the absence of this manufacturers are showing little interest in the German product, on which prices were fixed some weeks ago. There is considerable speculation as to whether there will be any difference between the Alsatian and German products, although it is generally conceded that higher prices will rule than prevailed last season. There is very little demand for spot potash, and muriate is being firmly held at \$2.65 per unit, with very small stocks of either kainit or manure salt. There is a vessel due late this month from which muriate is obtainable at \$2.50@2.60, kainit at \$2.25@2.35, and manure salt at \$2.15@2.25. For August-September arrival these prices could be shaded about 5 per cent.

Fish Scrap. The prevailing prices on this article have proved so attractive and so much higher than the fish factories have realized for their product for some years past that quite a number of contracts have been booked, subject to catch and "if made," thus assuring producers of at least \$7.50 and 10c. for the dry scrap, f.o.b. their factories. Fish scrap on this basis figures lower than other animal ammoniates.

Bone Meal. The market is practically bare of both raw and steamed bone meal, but such small stocks of 3 and 50 per cent as are obtainable are being held as high as \$54 per ton, in buyers' bags, f.o.b. Baltimore, and even at this price there is only a limited tonnage offered. While the demand for 4½ and 45 per cent raw bone meal is light, resale lots are offering at \$63 per ton, packed in second hand bags, f.o.b. Baltimore, but on account of price being so high buyers are going very cautiously in their purchases.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.	\$0.15 - \$0.20	\$0.15 - \$0.25
Acetone.....	lb.	3.30 - 3.75	2.10 - 2.22
Acid, acetic, 28 per cent.....	ewt.	6.50 - 7.50	4.00 - 4.50
Acetic, 56 per cent.....	ewt.	13.50 - 14.00	8.50 - 9.50
Acetic, glacial, 99½ per cent.....	arbov.	13.50 - 14.00	14.50 - 15.00
Boric, crystals.....	lb.	15 - 15	16 - 17
Boric, powder.....	lb.	15 - 15	16 - 17
Citric.....	lb.	8.5 - 10.0	1.17 - 1.18
Hydrochloric (nominal).....	ewt.	2.00 - 3.00	3.10 - 4.00
Hydrofluoric, 52 per cent.....	lb.	12 - 14	14 - 17
Lactic, 44 per cent tech.....	lb.	11 - 11	12 - 15
Lactic, 22 per cent tech.....	lb.	14 - 15	16 - 17
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.	06 - 07	07 - 08
Nitric, 40 deg.....	lb.	07 - 08	08 - 09
Nitric, 42 deg.....	lb.	55 - 57	60 - 65
Oxalic, crystals.....	lb.	14 - 23	24 - 25
Phosphoric, Ortho, 50 per cent solution.....	lb.	28 - 35	29 - 30
Picric.....	lb.	2.25 - 2.55	2.60 - 2.65
Pyrazolic, resublimed.....	lb.	14.00 - 16.00	18.00 - 20.00
Sulphuric, 60 deg., tank cars.....	ton	16.00 - 17.00	18.00 - 20.00
Sulphuric, 60 deg., drums.....	ton	26.00 - 28.00	37.00 - 42.00
Sulphuric, 66 deg., tank cars.....	ton	27.00 - 30.00	38.00 - 42.00
Sulphuric, 66 deg., drums.....	ton	32.00 - 35.00	40.00 - 45.00
Sulphuric, 66 deg., carboys.....	ton	1.45 - 1.50	1.55 - 1.60
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	60 - 70	80 - 90
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	60 - 70	80 - 85
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	1.20 - 1.40	1.50 - 1.60
Tannic, U. S. P.....	lb.	5.10 - 5.50	6.00 - 7.00
Tannic (tech).....	lb.	3.25 - 3.30	3.50 - 3.55
Tartaric, crystals.....	lb.	1.10 - 1.15	1.05 - 1.10
Tungstic, per lb. of WO.....	lb.	0.40 - 0.5	0.5 - 0.6
Alcohol, Ethyl (nominal).....	gal.	0.7 - 0.8	0.9 - 0.9
Alcohol, Methyl, 95%.....	gal.	0.15 - 0.18	0.19 - 0.20
Alcohol, Methyl, pure.....	gal.	0.02 - 0.03	0.03 - 0.05
Alcohol, denatured, 188 proof (nominal).....	gal.	0.03 - 0.04	0.04 - 0.06
Alcohol, denatured, 190 proof (nominal).....	gal.	0.08 - 0.10	0.11 - 0.12
Alum., ammonia lump.....	lb.	0.16 - 0.21	0.22 - 0.23
Alum., potash lump.....	lb.	150.00 - 160.00	24 - 25
Alum., chrome lump.....	lb.	0.21 - 0.23	0.11 - 0.12
Aluminum sulphate, commercial.....	lb.	0.04 - 0.05	0.05 - 0.06
Aluminum sulphate, iron free.....	lb.	0.09 - 0.10	0.08 - 0.09
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	0.01 - 0.02	0.02 - 0.03
Ammonia, anhydrous, cylinders (100-150 lb.).....	lb.	0.75 - 0.85	0.90 - 1.00
Ammonium carbonate, powder.....	lb.	0.16 - 0.18	0.17 - 0.18
Ammonium chloride, granular (white sal-ammoniac) (nominal).....	lb.	0.12 - 0.13	0.13 - 0.14
Ammonium chloride, granular (gray sal-ammoniac).....	lb.	0.09 - 0.10	0.11 - 0.12
Ammonium nitrate.....	lb.	0.07 - 0.08	0.08 - 0.09
Ammonium sulphate.....	lb.	5.00 - 5.25	5.00 - 5.25
Amylacetate.....	gal.	4.75 - 5.25	16 - 17
Amylacetate, tech.....	gal.	22 - 23	22 - 23
Arsenic, oxide, lumps (white arsenic).....	lb.	150.00 - 160.00	24 - 25
Arsenic, sulphide, powdered (red arsenic).....	lb.	0.21 - 0.23	0.11 - 0.12
Barium chloride.....	ton	0.09 - 0.11	0.05 - 0.06
Barium dioxide (peroxide).....	lb.	0.04 - 0.05	0.05 - 0.06
Barium nitrate.....	lb.	0.04 - 0.05	0.05 - 0.06
Barium sulphate (precip) (blanc fixe).....	lb.	0.04 - 0.05	0.05 - 0.06
Bleaching powder (see calcium hypochlorite).....	lb.	0.04 - 0.05	0.05 - 0.06
Blue vitriol (see copper sulphate).....	lb.	0.04 - 0.05	0.05 - 0.06
Borax (see sodium borate).....	lb.	0.04 - 0.05	0.05 - 0.06
Brimstone (see sulphur, roll).....	lb.	0.04 - 0.05	0.05 - 0.06
Bromine.....	lb.	0.04 - 0.05	0.05 - 0.06
Calcium acetate.....	ewt.	0.04 - 0.05	0.05 - 0.06
Calcium carbide.....	lb.	0.04 - 0.05	0.05 - 0.06
Calcium chloride, fused, lump.....	ton	0.04 - 0.05	0.05 - 0.06
Calcium chloride, granulated.....	lb.	0.04 - 0.05	0.05 - 0.06
Calcium hypochlorite (bleaching powder).....	ewt.	0.04 - 0.05	0.05 - 0.06
Calcium peroxide.....	lb.	0.04 - 0.05	0.05 - 0.06
Calcium phosphate, monobasic.....	lb.	0.04 - 0.05	0.05 - 0.06
Calcium sulphate, pure.....	lb.	0.04 - 0.05	0.05 - 0.06
Carbon bisulphide.....	lb.	0.04 - 0.05	0.05 - 0.06
Carbon tetrachloride, drums.....	lb.	0.04 - 0.05	0.05 - 0.06
Carbonyl chloride (phosgene).....	lb.	0.04 - 0.05	0.05 - 0.06
Caustic potash (see potassium hydroxide).....	lb.	0.04 - 0.05	0.05 - 0.06
Caustic soda (see sodium hydroxide).....	lb.	0.04 - 0.05	0.05 - 0.06
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	0.04 - 0.05	0.05 - 0.06
Chloroform.....	lb.	0.04 - 0.05	0.05 - 0.06
Cobalt oxide.....	lb.	0.04 - 0.05	0.05 - 0.06
Copperas (see iron sulphate).....	lb.	0.04 - 0.05	0.05 - 0.06
Copper carbonate, green precipitate.....	lb.	0.04 - 0.05	0.05 - 0.06
Copper cyanide.....	lb.	0.04 - 0.05	0.05 - 0.06
Copper sulphate, crystals.....	lb.	0.04 - 0.05	0.05 - 0.06
Cream of tartar (see potassium bitartrate).....	lb.	0.04 - 0.05	0.05 - 0.06
Epsom salt (see magnesium sulphate).....	lb.	0.04 - 0.05	0.05 - 0.06
Ethyl Acetate Com. 85%.....	gal.	0.04 - 0.05	0.05 - 0.06
Ethyl Acetate pure (acetic ether 98% to 100%).....	gal.	0.04 - 0.05	0.05 - 0.06
Formaldehyde, 40 per cent (nominal).....	lb.	0.04 - 0.05	0.05 - 0.06
Fusel oil, ref.....	gal.	0.04 - 0.05	0.05 - 0.06
Fusel oil, crude (nominal).....	gal.	0.04 - 0.05	0.05 - 0.06
Glauber's salt (see sodium sulphate).....	lb.	0.04 - 0.05	0.05 - 0.06
Glycerine.....	lb.	0.04 - 0.05	0.05 - 0.06
Iodine, resublimed.....	lb.	0.04 - 0.05	0.05 - 0.06
Iron oxide, red.....	lb.	0.04 - 0.05	0.05 - 0.06
Iron sulphate (copperas).....	ewt.	0.04 - 0.05	0.05 - 0.06
Lead acetate, normal.....	lb.	0.04 - 0.05	0.05 - 0.06
Lead arsenate (paste).....	lb.	0.04 - 0.05	0.05 - 0.06
Lead nitrate, crystals.....	lb.	0.04 - 0.05	0.05 - 0.06
Litharge.....	lb.	0.04 - 0.05	0.05 - 0.06
Lithium carbonate.....	lb.	0.04 - 0.05	0.05 - 0.06
Magnesium carbonate, technical.....	lb.	0.04 - 0.05	0.05 - 0.06
Magnesium sulphate, U. S. P.....	100 lb.	0.04 - 0.05	0.05 - 0.06
Magnesium sulphate, commercial.....	100 lb.	0.04 - 0.05	0.05 - 0.06
Nickel salt, double.....	lb.	0.04 - 0.05	0.05 - 0.06
Nickel salt, single.....	lb.	0.04 - 0.05	0.05 - 0.06
Phosgene (see carbonyl chloride).....	lb.	0.04 - 0.05	0.05 - 0.06
Phosphorus, red.....	lb.	0.04 - 0.05	0.05 - 0.06
Phosphorus, yellow.....	lb.	0.04 - 0.05	0.05 - 0.06
Potassium bichromate.....	lb.	0.04 - 0.05	0.05 - 0.06

	Carlots	Less Carlots
Potassium bitartrate (cream of Tartar).....	lb. \$0.52 - \$0.56	\$0.57 - \$0.58
Potassium bromide, granular.....	lb. .80 - .85	.90 - .95
Potassium carbonate, U. S. P.....	lb. .20 - .25	.47 - .50
Potassium carbonate, crude.....	lb. .15 - .17	.26 - .28
Potassium chlorate, crystals.....	lb. .30 - .33	.18 - .20
Potassium hydroxide (caustic potash).....	lb. .15 - .17	.35 - .38
Potassium iodide.....	lb. .75 - .80	3.35 - 3.60
Potassium nitrate.....	lb. .90 - 1.00	.19 - .21
Potassium permanganate.....	lb. .32 - .36	.85 - .95
Potassium prussiate, red.....	ton \$225.00 - 240.00	1.05 - 1.10
Potassium prussiate, yellow.....		.35 - .40
Potassium sulphate (powdered).....		
Rochelle salts (see sodium potas. tartrate).....		
Sal ammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake.....	ton 40.00 - 50.00	
Silver cyanide (nominal).....	oz. 1.25 - 1.30	
Silver nitrate (nominal).....	oz. .74 - .76	
Soda ash, light.....	100 lb. 3.50 - 3.60	
Soda ash, dense.....	100 lb. 3.55 - 3.65	
Sodium acetate.....	lb. .08 - .09	.09 - .12
Sodium bicarbonate.....	100 lb. 2.45 - 2.60	2.75 - 3.50
Sodium bichromate.....	lb. .24 - .27	.28 - .29
Sodium bisulphate (nitre cake).....	ton 7.00 - 7.50	8.00 - 10.00
Sodium bisulphate Powdered.....	lb. .06 - .064	.07 - .10
Sodium borate (borax).....	lb. .09 - .10	.11 - .12
Sodium carbonate (sod. soda).....	100 lb. 1.50 - 1.80	1.80 - 2.00
Sodium chloride.....	lb. .11 - .12	.12 - .13
Sodium cyanide, 96-98 per cent.....	lb. .25 - .30	.32 - .35
Sodium fluoride.....	lb. .18 - .19	.19 - .20
Sodium hydroxide (caustic soda).....	100 lb. 6.50 - 7.50	
Sodium hypsulphite.....	lb. .03 - .04	
Sodium molybdate.....	lb. 2.50 - 3.25	3.25 - 4.00
Sodium nitrate.....	100 lb. 3.00 - 3.25	3.75 - 4.00
Sodium nitrite.....	lb. .16 - .18	.19 - .20
Sodium peroxide, powdered.....	lb. .32 - .35	.35 - .40
Sodium phosphate, dibasic.....	lb. .03 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts) lb.		.39 - .40
Sodium prussiate, yellow.....	lb. .23 - .27	.31 - .32
Sodium silicate, solution (40 deg.).....	lb. .01 - .01	.02 - .024
Sodium silicate, solution (60 deg.).....	lb. .02 - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt) lb.	1.60 - 1.70	1.75 - 2.50
Sodium sulphide, crystal, 60-62 per cent (cone) lb.	.09 - .10	.10 - .11
Sodium sulphite, crystals.....	lb. .03 - .04	.04 - .06
Strontium nitrate, powdered.....	lb. .17 - .18	.19 - .20
Sulphur chloride red.....	lb. .08 - .09	.10 - .10
Sulphur, crude.....	ton 25.00 - 30.00	
Sulphur dioxide, liquid, cylinders.....	lb. .09 - .10	.10 - .12
Sulphur (sublimed), flour.....	100 lb. 3.80 - 4.35	
Sulphur, roll (brimstone).....	100 lb. 3.40 - 3.90	
Tin bichloride (stannous).....	lb. .42 - .44	.45 - .46
Tin oxide.....	lb. .16 - .18	.19 - .20
Zinc carbonate, precipitate.....	lb. .13 - .13	.13 - .17
Zinc chloride, gran.....	lb. .45 - .49	.50 - .60
Zinc cyanide.....	lb. .11 - .12	.13 - .15
Zinc dust.....	lb. .10 - .13	
Zinc oxide, U. S. P.....	lb. .03 - .03	.04 - .06
Zinc sulphate.....		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude.....	lb. \$1.40 - \$1.50
Alpha naphthol, refined.....	lb. 1.60 - 1.70
Alpha naphthylamine.....	lb. .53 - .55
Aniline oil, drums extra.....	lb. .34 - .36
Aniline salts.....	lb. .41 - .45
Anthracene, 80% in drums (100 lb.).....	lb. .90 - 1.00
Benzaldehyde (f.c.).....	lb. 2.00 - 2.10
Benzidine, base.....	lb. 1.35 - 1.40
Benzidine, sulphate.....	lb. 1.15 - 1.25
Benzoic acid, U. S. P.....	lb. .90 - 1.00
Benzoate of soda, U. S. P.....	lb. .80 - .90
Benzol, pure, water-white, in drums (100 lb.).....	gal. .35 - .40
Benzol, 90% in drums (100 lb.).....	gal. .33 - .38
Benzyl chloride, 95-97% refined.....	lb. .35 - .40
Benzyl chloride, tech.....	lb. .25 - .35
Beta naphthol benzoate (nominal).....	lb. 3.50 - 4.00
Beta naphthol, sublimed (nominal).....	lb. .80 - .88
Beta naphthol, tech (nominal).....	lb. 2.25 - 2.40
Beta naphthylamine, sublimed.....	lb. .18 - .19
Cresol, U. S. P., in drums (100 lb.).....	lb. .23 - .25
Ortho-cresol, in drums (100 lb.).....	gal. 1.05 - 1.15
Cresylic acid, 97-99%, straw color, in drums.....	gal. 1.00 - 1.05
Cresylic acid, 95-97% dark, in drums.....	gal. .65 - .75
Cresylic acid, 50% first quality, drums.....	lb. .08 - .10
Dichlorobenzol.....	lb. 1.50 - 1.60
Diethylaniline.....	lb. 1.35 - 1.45
Oimethylaniline.....	lb. .30 - .37
Dinitrobenzol.....	lb. .32 - .35
Dinitrochlorbenzol.....	lb. .45 - .55
Dinitronaphthalene.....	lb. .40 - .45
Dinitrophenol.....	lb. .40 - .45
Dinitrotoluol.....	lb. .38 - .40
Dip oil, 25% tar acids, car lots, in drums.....	gal. .80 - .85
Diphenylamine (nominal).....	lb. 2.25 - 2.50
H-acid (nominal).....	lb. 1.23 - 1.30
Metaphenylenediamine.....	lb. .18 - .20
Monochlorobenzol.....	lb. 2.00 - 2.40
Monooethylaniline.....	lb. .19 - .19
Naphthalene crushed, in bbls. (250 lb.).....	lb. .25 - .25
Naphthalene, flake.....	lb. .14 - .15
Naphthalene, balls.....	lb. .40 - .50
Naphthionic acid, crude.....	lb. .18 - .25
Nitrobenzol.....	lb. 3.25 - 4.25
Nitro-naphthalene.....	lb. .15 - .20
Nitro-toluol.....	lb. .80 - 1.25
Ortho-amidophenol.....	lb. .35 - .40
Ortho-dichlor-benzol.....	lb. 2.50 - 3.00
Ortho-nitro-phenol.....	lb. 2.50 - 3.00
Ortho-nitro-toluol.....	lb. .08 - .12
Ortho-toluidine.....	lb. 1.40 - 1.50
Para-amidophenol, base.....	
Para-amidophenol, HCl.....	
Para-dichlor-benzol.....	
Paranitraniline.....	

Para-nitro-toluol.....	lb. \$01.35 - \$01.50
Paraphenylenediamine.....	lb. 2.50 - 2.75
Paratoluidine.....	lb. 2.00 - 2.50
Phthalic anhydride.....	lb. .65 - .75
Phenol, U. S. P., drums (dest.), (240 lb.).....	lb. .12 - .20
Pyridin.....	gal. 2.00 - 3.50
Resorcin, technical.....	lb. 4.25 - 4.50
Resorcin, pure.....	lb. 6.25 - 6.75
Salicylic acid, tech., in bbls. (110 lb.).....	lb. .50 - .52
Salicylic acid, U. S. P.....	lb. .50 - .60
Salol.....	lb. .90 - 1.00
Solvent naphtha, water-white, in drums, 100 gal.....	gal. .33 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal. .23 - .26
Sulphanilic acid, crude.....	lb. .32 - .35
Toluidine.....	lb. 1.70 - 2.50
Toluidine, mixed.....	lb. .45 - .55
Toluol, in tank cars.....	gal. .35 - .40
Toluol, in drums.....	gal. .38 - .40
Xylidine, drums, 100 gal.....	lb. .50 - .65
Xylol, pure, in drums.....	gal. .37 - .45
Xylol, pure, in tank cars.....	gal. .35 - .45
Xylol, commercial, in drums, 100 gal.....	gal. .37 - .45
Xylol, commercial, in tank cars.....	gal. .23 - .27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb. \$0.36 - \$0.39
Beeswax, refined, light.....	lb. .39 - .40
Beeswax, white pure.....	lb. .63 - .68
Carnauba, No. 1 (nominal).....	lb. 1.00 - 1.05
Carnauba, No. 2, regular (nominal).....	lb. .85 - .88
Carnauba, No. 3, North Country.....	lb. .36 - .37
Japan.....	lb. .19 - .19
Montan, crude.....	lb. .23 - .25
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb. .09 - .09
Paraffine waxes, crude, scale 124-126 m.p.....	lb. .09 - .10
Paraffine waxes, refined, 118-120 m.p.....	lb. .11 - .12
Paraffine waxes, refined, 128-130 m.p.....	lb. .14 - .15
Paraffine waxes, refined, 133-135 m.p.....	lb. .16 - .17
Paraffine waxes, refined, 135-137 m.p.....	lb. .17 - .18
Stearic acid, single pressed.....	lb. .25 - .26
Stearic acid, double pressed.....	lb. .26 - .27
Stearic acid, triple pressed.....	lb. .27 - .28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940.....	gal. \$1.80
Pine oil, pure, dest. dist.....	gal. 1.60
Pine tar oil, ref., sp. gr. 1.025-1.035.....	gal. 4.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal. 35
Pine tar oil, double ref., sp. gr. 0.965-0.990.....	gal. .85
Pine tar, ref., thin, sp. gr. 1.080-1.060.....	gal. .36
Turpentine, crude, sp. gr. 0.900-0.970.....	gal. 1.75
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....	gal. 35
Pinewood creosote, ref.....	gal. 52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.....	280 lb. \$12.25 - \$16.00
Rosin E-I.....	280 lb. 16.10 - 17.25
Rosin K-N.....	280 lb. 16.25 - 17.35
Rosin W. G.-W. W.....	280 lb. 16.50 - 16.70
Wood rosin, bbl.....	280 lb. 15.00 -
Spirits of turpentine.....	gal. 1.58 -
Wood turpentine, steam dist.....	gal. -
Wood turpentine, dest. dist.....	gal. -
Pine tar pitch, bbl.....	200 lb. 8.50 -
Tar, kiln burned, bbl. (500 lb.).....	bbl. 14.50 - 15.00
Retort tar, bbl.....	500 lb. 15.00 - 15.50
Rosin oil, first run.....	gal. .67 -
Rosin oil, second run.....	gal. .70 -
Rosin oil, third run.....	gal. .67 -

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal. \$0.40
70-72 deg., steel bbls. (85 lb.).....	gal. .38
68-70 deg., steel bbls. (85 lb.).....	gal. .37
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal. .29

Crude Rubber

Para-Upriver fine.....	lb. \$0.34 - \$0.35
Upriver coarse.....	lb. .24 - .24
Upriver cauchó ball.....	lb. .26 - .26
Plantation—First latex crepe.....	lb. .32 - .33
Ribbed smoked sheets.....	lb. .33 - .33
Brown crepe, thin, clean.....	lb. .32 - .32
Amber crepe No. 1.....	lb. .35 - .35

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.....	lb. \$0.17 - \$0.18
Castor oil, AA, in bbls.....	lb. .19 - .19
China wood oil, in bbls.....	lb. .16 - .16
Cocoonut oil, Ceylon grade, in bbls.....	lb. .16 - .17
Cocoonut oil, Cochín grade, in bbls (nominal).....	lb. .18 - .18
Corn oil, crude, in bbls.....	lb. .16 - .16
Cottonseed oil, crude (f.o.b. mill).....	lb. .10 - .11
Cottonseed oil, summer yellow.....	lb. .18 - .19
Cottonseed oil, winter yellow.....	lb. .21 - .22
Lined oil, raw, car lots (domestic).....	gal. 1.10 -
Linseed oil, raw, tank cars (domestic).....	gal. 1.30 -
Linseed oil, boiled, car lots (domestic).....	gal. 1.35 -

Olive oil, commercial.....	gal.	3 75	—	11
Palm, Lagos.....	lb.	10 1/2	—	10 1/2
Palm, bright red.....	lb.	10	—	12
Palm, Niger.....	lb.	11	—	15
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	13	—	24
Peanut oil, refined, in bbls.....	lb.	1 72	—	1 72
Rapeseed oil, refined in bbls.....	gal.	1 70	—	1 85
Rapeseed oil, blown, in bbls.....	gal.	1 80	—	1 85
Soya bean oil (Manchurian), in bbls N. Y.....	lb.	16	—	16 1/2
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	10 1/2	—	11

FISH

Winter pressed Menhaden.....	gal.	\$1 17	—	\$1 18
Yellow bleached Menhaden.....	gal.	1 20	—	1 22
White bleached Menhaden.....	gal.	1 23	—	1 24
Blown Menhaden.....	gal.	1 30	—	1 32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$22 00	—	25 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18 00	—	20 00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8 00	—	10 00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23 00	—	25 00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16 00	—	19 00
Barytes, crude, 88% @ 94% ba., Cartersville	net ton	12 00	—	—
Barytes, floated, f.o.b. St. Louis	net ton	26 50	—	28 00
Barytes, crude, min. 98% ba., Missouri	net ton	11 00	—	11 25
Blanc fixe, dry.....	lb.	05	—	06
Blanc fixe, pulp.....	net ton	60 00	—	80 00
Casein.....	lb.	15	—	18
Chalk, domestic, extra light.....	lb.	05	—	06
Chalk, domestic, light.....	lb.	04	—	05 1/2
Chalk, domestic, heavy.....	lb.	04	—	05
Chalk, English, extra light.....	lb.	05	—	07
Chalk, English, light.....	lb.	05	—	06
Chalk, English, dense.....	lb.	04 1/2	—	05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9 00	—	12 00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12 00	—	15 00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18 00	—	22 00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8 00	—	12 00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15 00	—	40 00
China clay (Kaolin), imported, lump.....	net ton	25 00	—	35 00
China clay (Kaolin), imported, powdered.....	net ton	30 00	—	60 00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	7 50	—	8 00
Feldspar, crude, f.o.b. Maine.....	net ton	7 50	—	10 00
Feldspar, ground, f.o.b. Maine.....	net ton	21 00	—	23 00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17 00	—	20 00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17 00	—	20 00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25 00	—	—
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18 00	—	—
Fuller's earth, imported, powdered.....	net ton	35 00	—	40 00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	—	—	01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	—	—	02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	—	—	05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	—	—	10
Graphite, crucible, 85% carbon.....	lb.	—	—	08
Graphite, crucible, 88% carbon.....	lb.	—	—	09 1/2
Graphite, crucible, 90% carbon.....	lb.	—	—	10 1/2
Pumice stone, imported, lump.....	lb.	04	—	50
Pumice stone, domestic, lump.....	lb.	06	—	—
Pumice stone, ground.....	lb.	04	—	07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	—	—	10 00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore	net ton	—	—	14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	—	—	12 00
Quartz, lump, f.o.b. North Carolina.....	net ton	5 00	—	7 50
Shellac, orange fine.....	lb.	1 40	—	—
Shellac, orange superfine.....	lb.	1 50	—	—
Shellac, A. C. garnet.....	lb.	1 05	—	1 15
Shellac, T. N.....	lb.	1 20	—	1 30
Soapstone.....	ton	15 00	—	25 00
Talc, paper-making grades, f.o.b. Vermont.....	ton	9 50	—	14 00
Talc, roofing grades, f.o.b. Vermont.....	ton	8 20	—	9 00
Talc, rubber grades, f.o.b. Vermont.....	ton	9 00	—	15 00
Talc, powdered, Southern, f.o.b. cars.....	ton	12 00	—	15 00
Talc, imported.....	ton	60 00	—	70 00
Talc, California Talcum Powder grade.....	ton	20 00	—	35 00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots.....	net ton	90	—	100
Chrome brick, 9-in. str. and sizes, f.o.b. Baltimore	net ton	80	—	90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45	—	53
Fire clay brick, 1st quality, f.o.b. St. Louis.....	1,000	45	—	—
Fire clay brick, 1st quality, f.o.b. New Jersey.....	1,000	75	—	—
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40	—	—
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90	—	—
Magnesite brick, 9-in. sizes and shapes larger than 9-in.	net ton	90	—	100
Magnesite brick, f.o.b. Chester.....	net ton	55	—	—
Silica brick, 9-in. and 9-in. sizes, Chicago district.....	1,000	55	—	—
Silica brick, f.o.b. Birmingham.....	1,000	51	—	55
Silica brick, f.o.b. Mt. Union, Pa.....	1,000	50	—	55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	19	—	22
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	20	—	21
Ferro-manganese, 76-80% Mn.....	gross ton	190 00	—	225 00
Spiegelisen, 18-22% Mn.....	gross ton	75 00	—	—
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2 50	—	3 00
Ferro-silicon, 10-15%.....	gross ton	60 00	—	65 00
Ferro-silicon, 50%.....	gross ton	80 00	—	90 00
Ferro-silicon, 75%.....	gross ton	150 00	—	160 00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	1 10	—	1 15
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	7 00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6 50	—	7 75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	60	—	65
Chrome ore, 40%, min., Cr ₂ O ₃ f.o.b. Atlantic Seaboard.....	unit	70	—	85
*Coke, foundry, f.o.b. ovens.....	net ton	18 00	—	19 00
*Coke, furnace, f.o.b. ovens.....	net ton	17 50	—	18 50
*Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24 00	—	—
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17 50	—	—
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	—	—	25 00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	02	—	—
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	85	—	90
Manganese ore, chemical (MnO ₂).....	gross ton	75 00	—	85 00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂	lb.	1 00	—	—
Monazite, per unit of ThO ₂	unit	42 00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	12	—	—
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport.....	unit	16 1/2	—	—
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport.....	unit	12	—	14
Pyrites, domestic, fines.....	unit	12	—	14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	15	—	25
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃	unit	7 00	—	—
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃	unit	6 50	—	7 50
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2 75	—	3 00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2 75	—	3 00
Vanadium pentoxide, 99%.....	lb.	12 00	—	14 00
Vanadium Ore, per lb. of V contained.....	lb.	1 00	—	2 50
Zircon, washed, iron free.....	lb.	10	—	—

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	19 00
Aluminum, 98 to 99 per cent.....	33 00
Antimony, wholesale lots.....	8 00
Nickel, ordinary.....	43 00
Nickel, electrolytic.....	45 00
Tin, Straits, spot.....	50 25
Lead, New York, spot.....	8 50 @ 8 75
Lead, E. St. Louis, spot.....	8 35 @ 8 40
Zinc, spot, New York.....	8 25
Zinc, spot, E. St. Louis.....	7 90

OTHER METALS

	oz.	\$0.99
Silver.....	—	—
Cadmium.....	1 40 @	1 50
Bismuth (500 lb. lots).....	lb.	2 70
Cobalt.....	2 50 @	3 00
Magnesium (f.o.b. Niagara Falls).....	lb.	1 75
Platinum.....	oz.	80 @ 85
Iridium.....	oz.	300
Palladium.....	oz.	75 @ 80
Mercury.....	75 lb.	90 @ 92

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	33 50
Copper bottoms.....	38 00
Copper rods.....	38 00 @ 40 00
High brass wire and sheets.....	30 25
High brass rods.....	25 00
Low brass wire and sheets.....	28 50
Low brass rods.....	29 00
Brazed brass tubing.....	43 25
Brazed bronze tubing.....	41 75
Seamless copper tubing.....	34 00
Seamless high brass tubing.....	33 00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap.....	23 00 @ 23 50
Aluminum, sheet scrap.....	23 00 @ 23 50
Copper, heavy machinery comp.....	14 50 @ 15 00
Copper, heavy and wire.....	14 25 @ 14 75
Copper, light and bottoms.....	12 75 @ 13 75
Copper, heavy cut and crucible.....	15 50 @ 16 00
Brass, heavy.....	9 25 @ 10 00
Brass, light.....	7 25 @ 7 75
No. 1 clean brass turnings.....	9 00 @ 9 50
No. 1 comp. turnings.....	12 50 @ 13 00
Lead, tea.....	4 50 @ 5 00
Lead, heavy.....	7 00 @ 7 50
Zinc, scrap.....	5 00 @ 5 50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland			Chicago		
	Current	Month Ago	One Year Ago	Current	Month Ago	One Year Ago	Current	Month Ago	One Year Ago
Structural shapes.....	\$4 47	\$3 97	\$3 47	\$5 50	\$3 37	\$3 97	\$3 47	\$3 47	\$3 47
Soft steel bars.....	4 62	4 12	3 37	5 00	3 27	3 87	3 37	3 87	3 37
Soft steel bar shapes.....	4 62	4 12	3 37	5 00	3 27	3 87	3 37	3 87	3 37
Soft steel bands.....	6 32	5 32	4 07	6 25	—	—	—	—	—
Plat. s. 1/2 to 1 in. thick.....	4 68	4 17	3 67	5 00	3 57	4 17	3 67	4 17	3 67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

NAUGATUCK—The Naugatuck Chemical Co. will soon award the contract for the construction of a 4-story, 60x80-ft. plant addition. Estimated cost, \$75,000. Lockwood, Greene & Co., Federal St., Boston, engrs.

STAMFORD—The Perfection Enameling & Painting Co., Main and Grove Sts., plans to build a 2-story, 100x125-ft. manufacturing building.

Illinois

BUCKLEY—The Bd. Educ. plans to build a 1-story, 82x115-ft. high school. An experimental laboratory will be installed in same. Estimated cost, \$65,000. J. N. Coleman, 6257 St. Lawrence Ave., Chicago, archt.

CHICAGO—The Great Western Smelting & Refining Co., 600 West 41st St., plans to build a smelting plant consisting of three large 1-story units and an office building on Union Ave. and 51st St. Estimated cost, \$1,000,000. Henry L. Newhouse, 4630 Prairie Ave., archt.

Indiana

PORTLAND—The Portland Oil & Refining Co. plans to build a refinery. H. J. McConoley, secy. and treas.

Iowa

BAYARD—The Consolidated School Dist. is building a 2-story, 75x187-ft. grade and high school here. A chemical and physical laboratory will be installed in same. Estimated cost, \$180,000.

IOWA CITY—The State Bd. Educ. plans to build a library and chemistry building at the University of Iowa. Estimated cost, \$2,000,000. W. H. Bates, secy.

OTTUMWA—The Bd. Educ. is having plans prepared for the construction of a 3-story high school here. Chemical laboratories will be installed in same. Estimated cost, \$700,000. Croft & Boerner, 833 Palace Bldg., Minneapolis, archts.

WOODWARD—The city rejected all bids for the construction of a disposal plant here. Estimated cost, \$25,000. M. I. Evinger, Davidson Bldg., Des Moines, engr.

Kansas

PAOLA—The city has awarded the contract for furnishing filters to the Pittsburgh Filter Co., 429 Rialto Bldg., Kansas City, Mo., at \$10,900.

Kentucky

LOUISVILLE—The Dixie Belle Refining Co., 701 Inter Saw Bldg., is receiving bids for the construction of a refinery on Western Parkway. Estimated cost, \$500,000. C. B. Haun, archt. Noted July 7, 1920.

Massachusetts

CAMBRIDGE—The city is having preliminary plans prepared for the construction of a filtration plant. Estimated cost, \$600,000. Johnson & Benham, 150 Nassau St., New York City, engrs.

EAST EVERETT—The Boston Varnish Co. will soon receive bids for an addition to the varnish manufacturing building here. Estimated cost, \$30,000. Charles L. Betton, 31 Exchange St., Lynn, archt.

SPRINGFIELD—The Brightwood Brass Fdry., 365 Birnie Ave., will build a 1- and 1½-story, 52x72-ft. foundry addition. Estimated cost, \$15,000. Work will be done by day labor. Noted May 19.

SPRINGFIELD—The Davitt Iron Fdry., 191 Liberty St., will build a 1- and 2-story, 55x105-ft. foundry. Estimated cost, \$15,000. Work will be done by day labor.

WATERTOWN—Lockwood, Greene & Co., archts., 60 Federal St., Boston, will soon receive bids for the construction of a

1-story, 200x230-ft. foundry at the plant for the Walker & Pratt Mfg. Co., 31 Union St., Boston.

WORCESTER—The Worcester Pressed Steel Co., Barber Ave., will build a 2-story plant addition. Estimated cost, \$25,000. Work will be done by day labor.

Michigan

KALAMAZOO—The Bd. Educ. plans to construct a junior high school. A small chemical laboratory will be installed in same. R. A. LeRoy, 122 Pratt Bldg., archt.

Minnesota

MINNEAPOLIS—The Bd. Educ. will soon receive bids for the construction of a 4-story, 220x300-ft. senior high school on 20th Ave. N. E. and Quincy St. A chemical and physical laboratory will be installed in same. Estimated cost, \$700,000. E. H. Enger, 3018 Third Ave., S., archt.

RENVILLE—The Bd. Educ. will receive bids about Aug. 15 for the construction of a 2-story, 146x273-ft. high and grade school. A chemical laboratory will be installed in same. Estimated cost, \$280,000. Croft & Boerner, 833 Palace Bldg., Minneapolis, archts. Noted May 19.

New Jersey

SHILOH—The School Bd. of Hopewell Twp., care of W. S. Garrison, Roadstown, plans to build a 2-story, 60x122-ft. high school addition on Salem Bridgeton Rd. A chemical laboratory will be installed in same. Estimated cost, \$90,000. H. A. Hill, Broad St. Bank Bldg., Trenton, archt.

New York

LONG ISLAND CITY—The Stein Hall & Co., Inc., 61 B'way, New York City, has awarded the contract for the construction of a 4-story factory on 6th St. and Jackson Ave. to the Turner Constr. Co., 244 Madison Ave., New York City. Estimated cost, \$400,000.

WEST POINT—Congress, Wash., D. C., appropriated \$18,000 for labor and material for the construction of a new dry cleaning, sterilizing and disinfecting building at the Military Academy here and \$12,000 for the purchase and installation of machinery and equipment in same.

Ohio

CINCINNATI—Readings, Panzer & Martin, archts., Palace Theatre Bldg., will soon award the contract for the construction of a 1-story, 100x157-ft. chemical warehouse on Dana Ave. for the E. K. Shannon Chemical Co., Dana Ave. and the Cincinnati, Lebanon & Northern R.R.

EATON—The city plans to construct a filtration plant for the local waterworks including filters, etc. Estimated cost, \$27,500.

LIMA—The city is having preliminary plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, \$1,000,000. Fuller & McClintock, 170 B'way, New York City, engrs.

South Dakota

MITCHELL—The Sisters of the Presentation Order will soon receive bids for the construction of a 3-story, 40x160-ft. hospital. A chemical laboratory will be installed in same. Estimated cost, \$125,000. Edwin H. Lundie, 530 Endicott Bldg., St. Paul, archt.

Virginia

HARRISONBURG—The city plans to construct a 3,000,000-gal. filtration plant, etc. Estimated cost, \$500,000. Roberts Eng. Co., Charleston, W. Va., engr.

Quebec

LEVIS—The Levis Pulp & Paper Co. will receive bids until Aug. 1 for the construction of a 100-ton pulp mill on St. Romuald Rd. Estimated cost, \$500,000. G. Breakey, Breakeyville-Levis, engr.

MONTREAL—The Standard Iron & Chemical Co., 524 Ambrose St., will soon receive bids for a 4-story addition to its plant here. Estimated cost, \$100,000.

Ontario

BELL RIVER—The Fraser & Brysow Lumber Co., Ltd., Castle Bldg., Ottawa, will soon receive bids for the construction of a ground wood pulp mill. Estimated cost, \$300,000.

CHATHAM—The city is having plans prepared for the construction of a pump-house including mechanical sand filters, etc. Estimated cost, \$50,000. E. A. James Co., 36 Toronto St., Toronto, engr.

FORT WILLIAM—John G. Sutherland, archt., Dayton, O., will receive bids until Aug. 1 for the construction of a pulp and paper mill at the mouth of the Mission River, for the Fort William Pulp & Paper Co., Ltd. Estimated cost, \$1,000,000.

KINCARDINE—The Town Council will receive bids about Aug. 2 for the construction of a filtration plant. Estimated cost, \$15,000. Mr. Dallyn, Parliament Bldgs., Toronto, engr.

PORT ARTHUR—The Nipigon Fibre & Paper Mills, Ltd., will receive bids until Aug. 15 for the construction of a 40-ton pulp mill in the Nipigon Dist. Estimated cost, \$200,000. J. A. Little, engr.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.